# S P A C E S T A T I O N

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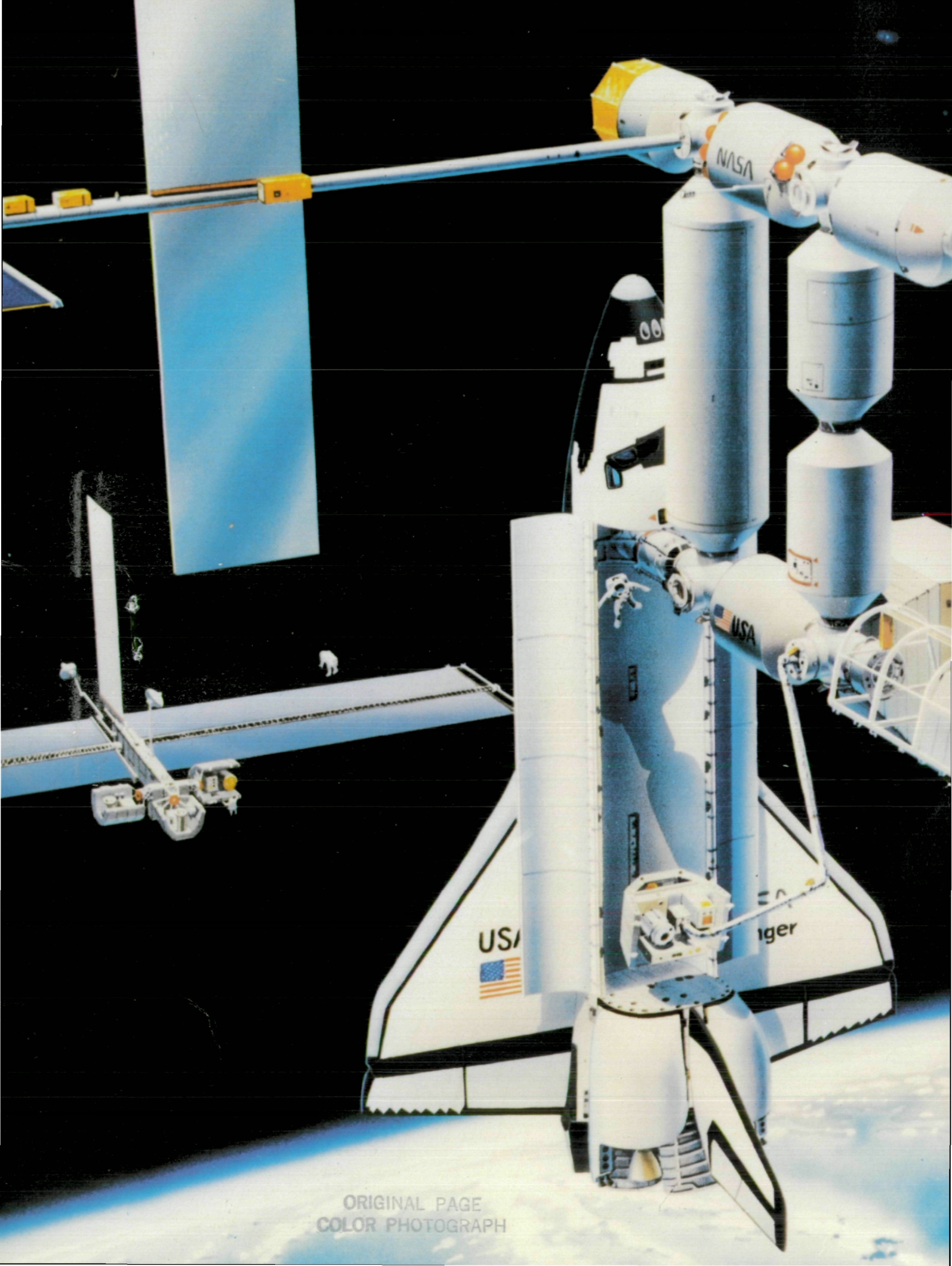
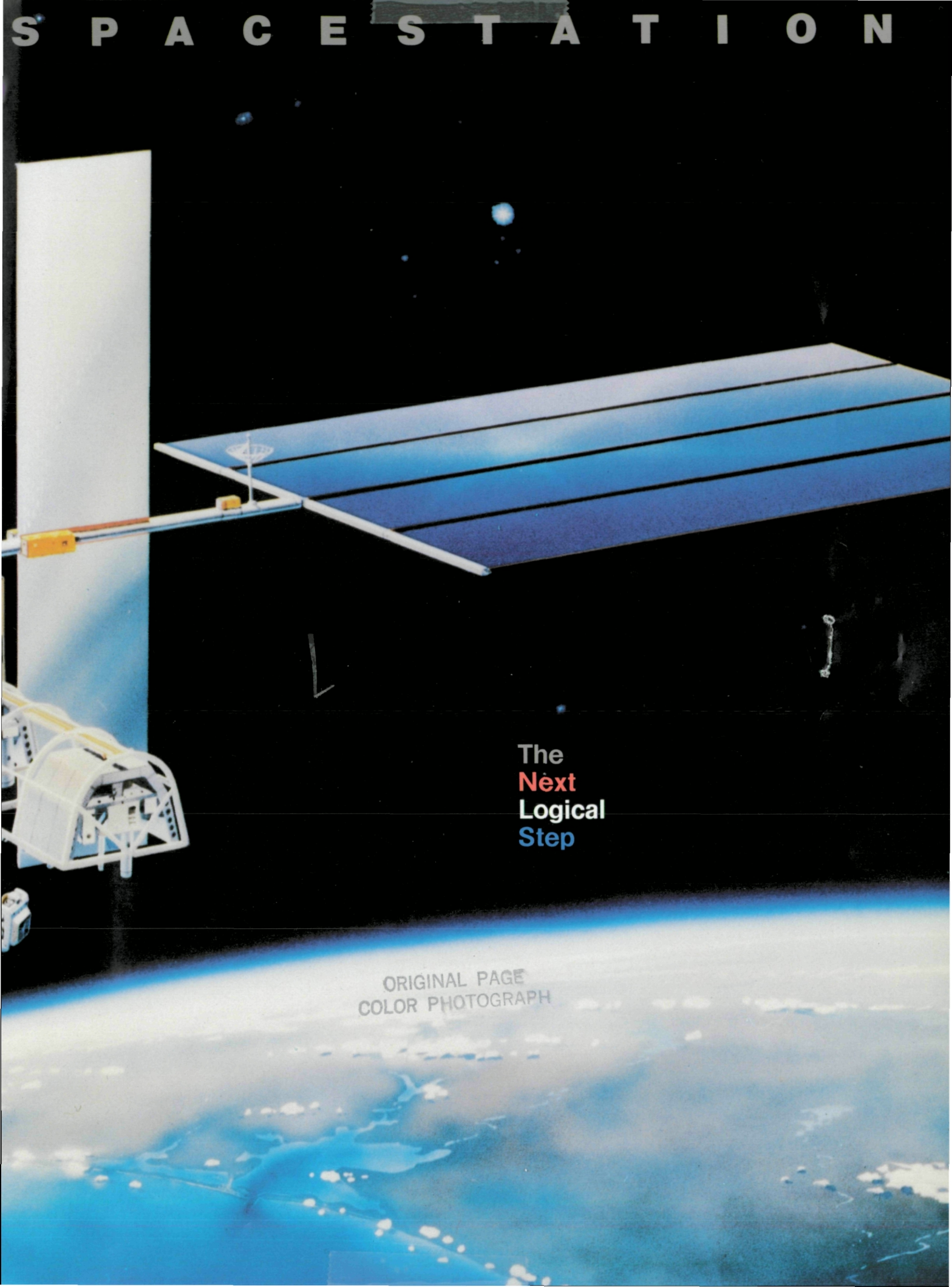
## The Next Logical Step



# SPACE STATION



The
Next
Logical
Step

After more than 25 years of experience in the exploration and uses of space, the United States is readying itself for another major advance—a permanent orbiting workshop and research center, a Space Station that will be able to grow in size and technological sophistication. This multipurpose Space Station will assure U.S. leadership in space during the years ahead.

# SPACE STATION

By Walter Froehlich

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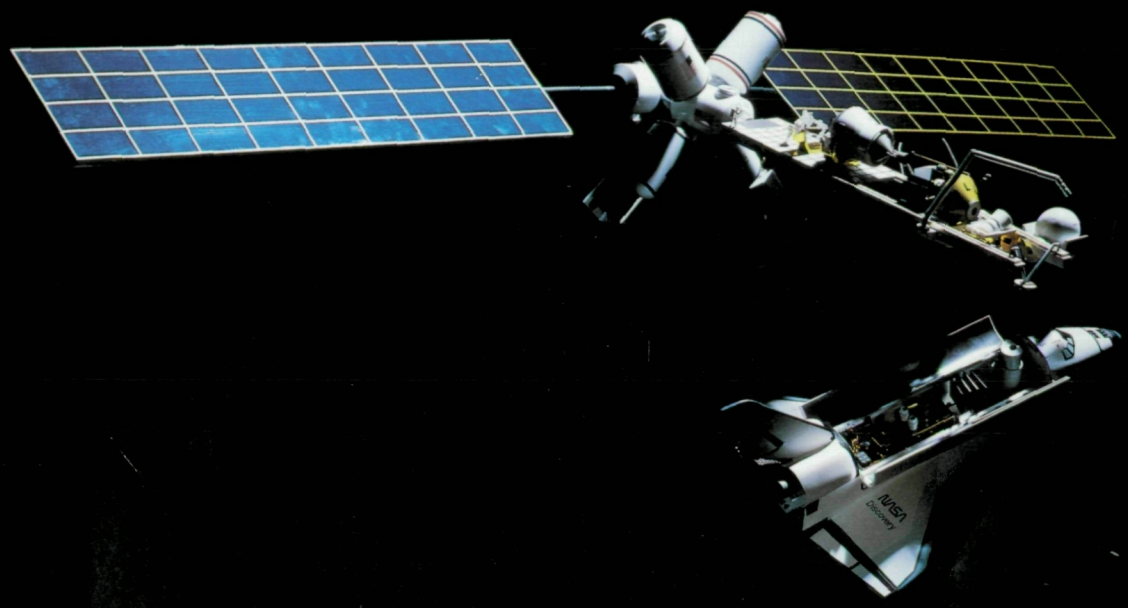


**"We can follow our dreams to distant stars, living and working in space for peaceful economic and scientific gain. Tonight, I am directing NASA to develop a permanently manned Space Station and to do it within a decade.**

***President Ronald Reagan***
***State of the Union Message***
***January 5, 1984***



# Introduction

The clock is ticking. The President set the deadline: *Do it within a decade.*

The assignment: *Develop a permanently manned Space Station.*

The goal: Some 3,600 days from now—give or take a few dozen days—the United States will possess a permanent human-built island in orbit on which men and women can live and work.

This Space Station is to be equipped to accommodate six to eight engineers, scientists, technicians or other specialists. Before they return to Earth after a few months in orbit, their places will be taken and their work continued by new crews—men and women who have gone into space to work.

Once the Station goes into operation early in the 1990s, the Earth's space environment will never be without the presence of Americans.

President Reagan stated the purpose: *for peaceful economic and scientific gain* and for *quantum leaps* in research and technology.

What will this Space Station be like? Why do we need it? How will it be built? Why must we start work on it now? What are the advantages and risks, the costs and side effects? What are the human, social and international implications? What does it mean to us? This brochure provides some of the answers.

The Space Station is a vital part of our nation's investment in science and technology. The pace and quality of our progress in science and technology will affect the competitive strength of our industries and have a strong impact on jobs and pay scales. These, in turn, will influence how well we live as individual citizens and as a nation.

As we plan and build the U.S. permanently manned Space Station, we are simultaneously helping to shape part of our nation's future.

*President and Mrs. Reagan greet astronauts Ken Mattingly (left) and Henry Hartsfield after their landing in the fourth Space Shuttle mission, which completed the Shuttle's series of orbital flight tests. Routine and dependable access to Earth orbit provided by the Shuttle makes a permanently manned Space Station the next logical step in space.*

# The Concept

## A Permanent Research and Work Center in Orbit

**"To maximize the unique advantages provided by the environment of space, we need to establish a permanent presence that enables us to work in space full time . . . A Space Station is, I believe, the next logical step in space."**

***James M. Beggs, NASA Administrator, at a hearing before the Subcommittee on Space Science and Applications, U.S. House of Representatives, February 1, 1984.***

From short-duration missions as occasional visitors and commuters we are about to start the transition to becoming year-round workers in space. Within a few years the United States will operate a permanent facility for human activities of unlimited duration in orbit.

After having launched astronauts on dozens of missions since the beginning of U.S. manned space flight in 1961, our nation is about to develop a new capability in space.

This new system—a *Space Station*—will be designed and built in the next eight to ten years from sections, or modules, prefabricated on the Earth. These will then be transported to orbit in the Shuttle's bus-size cargo bay. There, they will be unloaded and assembled by astronauts wearing space suits and propelling themselves with jet-powered backpacks.

While orbiting at an altitude of about 250 miles, these crews will use cranes and other tools designed especially for work in space.

### Modular Design Featured

One module will be furnished as living quarters for from six to eight persons; another module—or modules—will be outfitted as a combination workshop and laboratory. Environmental conditions inside the modules, resembling the interior of a passenger airplane cabin, will enable crews to work in Earth-like shirt-sleeve surroundings.

Other attached modules will carry utilities such as power generating machinery and still others will provide storage space for supplies and equipment. The Station will be self-sustaining for several weeks or even months. It will be partly independent from ground control. Crew members will have considerable discretion in their use of the facilities and in scheduling and carrying out their work.

### Space Station: Both Manned and Unmanned

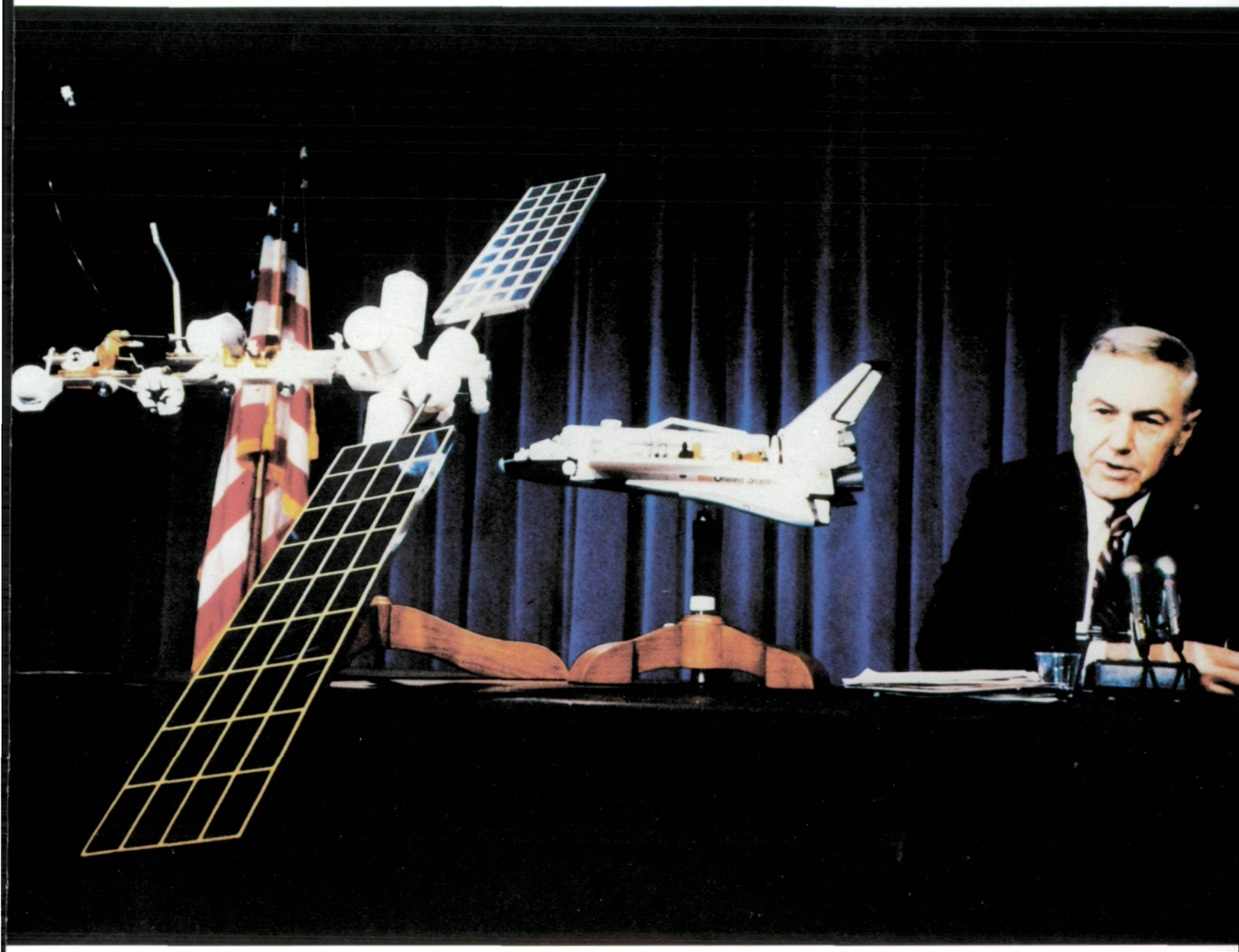
Attached outside the modules will be platforms called *pallets* for automated and remote-controlled experiments and observation instruments. Other instruments will be carried on unattached free-flying platforms in separate orbits nearby.

These unmanned portions of the Space Station complex will be important for experiments and observations requiring protection from the contamination and vibrations which are inevitably present in an inhabited spacecraft. These platforms are also necessary for scientific instruments requiring extremely precise pointing. Though these unmanned instruments may not require continuous human supervision or intervention, the Space Station crew can get to them when necessary for maintenance, adjustments, repairs and retrieval.

At intervals of several weeks, the Space Shuttle will arrive at the Station to deliver a replacement crew and new supplies. Some or all of the old crew members will then return to Earth in the Shuttle.

### Variety of Science Activities Planned

Among their numerous activities aboard the Station, crews will carry out basic research in medicine, astronomy, space physics and solar studies. They will conduct experiments in



*NASA Administrator James M. Beggs discusses the Space Station initiative at a White House press conference shortly after the Presidential decision to proceed with development.*

*Astronaut Bruce McCandless perches on the elbow of the Space Shuttle's arm-like crane developed for the U.S. by Canada and known as the Remote Manipulator System (RMS). Astronaut McCandless demonstrated the practicality of crews working in space outside of the Shuttle. In the 1990's astronauts routinely will work outside the Space Station to maintain and repair satellites and assemble large space structures.*

Earth sciences and in many other scientific disciplines. The crews will also work on technology experiments aimed at developing products and services useful for industrial customers and consumers.

Specially trained crew members will make Earth resources observations. Others will check out and launch automated spacecraft to higher orbits. Some crew members will provide in-orbit maintenance, repair and retrofit services for scientific and applications satellites.

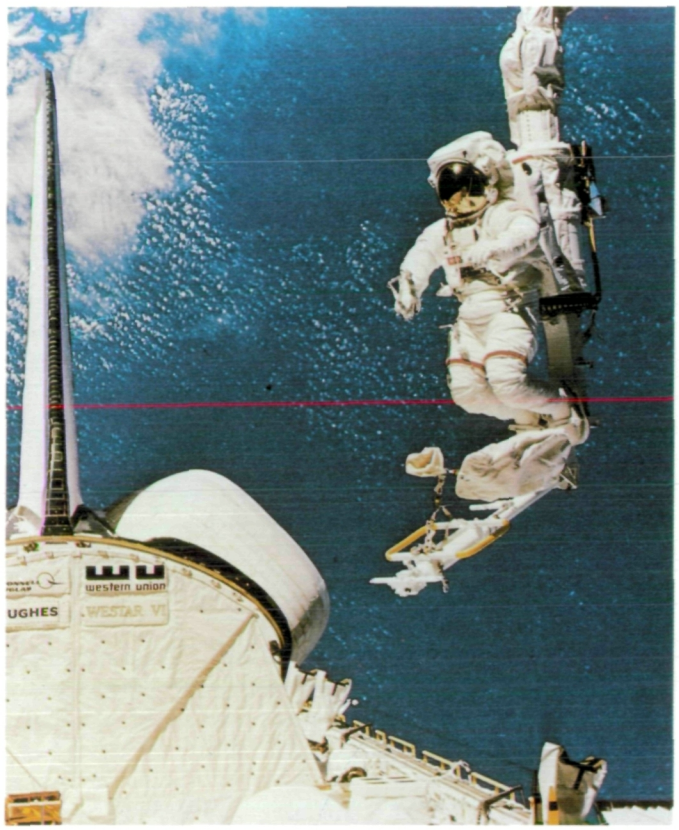
### An Evolutionary System

From the beginning the Station will be designed for evolutionary growth. Additional modules could later be connected to the Station if larger crews and more equipment were needed. Additional unmanned scientific platforms also could be added. The modular *building block* design will give flexibility and allow expansion, change and versatility.

Modules, instruments and other components which have become worn beyond cost-effective repairs or have become obsolete can be replaced.

With appropriate maintenance and replacements the Station can be kept inhabited and functioning well into the next century.

The Space Station will be built using the most advanced technologies available. Once in operation, the Space Station will become a spawning ground for innovation—a nurturing place for new technologies.

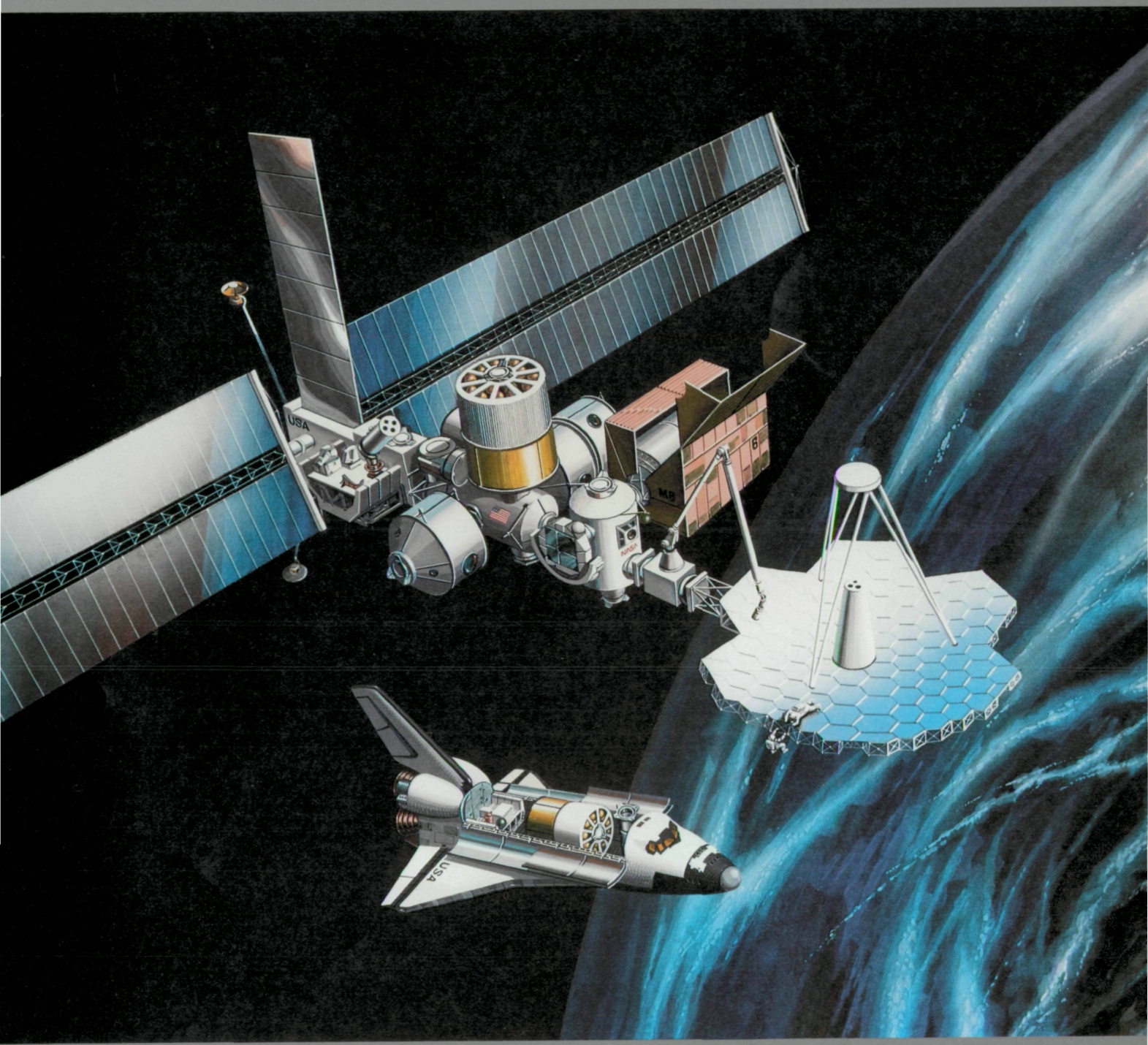



### A New National Laboratory

One of the Space Station's most crucial assignments will be to serve as a national laboratory. It is to be a center for the inception and development of the advanced technologies upon which our nation's economic and social well-being depends in an increasingly competitive and sophisticated world.

The intermittent visits of astronauts to Earth orbit will no longer suffice in the final years of this century, if our nation is to retain its hard-won preeminence in space. Sustaining America's competitive technological edge, from which we derive our standard of living, requires continuing renewal and advancement. The Space Station will help us do this. It will become a key element in our nation's technological investment strategy as we approach the 21st century.

*The Marshall Space Flight Center in Huntsville, Alabama, developed this Space Station configuration as part of the preliminary analysis conducted by NASA in 1982-83. The configuration illustrates three of the key functions to be carried out by the Space Station:* Scientific research*—the U-shaped pallet, near the base of the vertical radiator supports several scientific instruments including a large telescope.* Transportation*—later on, the Space Station will be the base for an Orbital Transfer Vehicle, shown here covered by a box-like hangar.* Assembly of large structures*—the Space Station will enable large structures, like the hexagonal antenna pictured at the right of the complex, to be put together and checked out.*



**"Silently drifting across the sky, it will resemble nothing so much as the imaginative creation of an inventive youngster with an Erector® set. It will consist of sleek metal cylinders, winglike panels, sinewy aluminum beams and long cranelike arms."**

***Description of the Space Station.*** **TIME,** ***February 6, 1984, p. 54.***

# How it Will Look

## Designed to Serve Our Nation

*This Space Station reference configuration known as the "Power Tower" is being studied extensively by NASA and its industrial and international partners. The configuration encompasses several characteristics essential to the Space Station concept: capability for evolution and growth, accommodation for scientific experiments, room and equipment to assemble large structures as well as facilities for proximity operations.*

How will the Space Station look? Like a house? Like a ship? Will it resemble the out-of-this-world science-fiction depictions of movies, newspapers and books?

It is like asking about next week's newspaper headlines. The events they will describe have not yet happened. So too with the Space Station. Detailed designs have not yet been completed. They will have to await the outcome of an extensive three-year NASA-industry study that is now underway.

NASA intends the Space Station to be *customer-friendly.* This means it will be built to be as suitable and as adaptable as possible for the wide spectrum of tasks its many users want to accomplish.

In April 1983 eight U.S. companies under contract with NASA completed investigations on the kinds of experiments and work assignments the Space Station will need to accommodate.

NASA is continuing these studies. NASA specialists are presently talking with representatives of aerospace and non-aerospace industries, universities, private research centers and other government departments and agencies to learn more about the work they want to do in space.

### User Needs Shape Space Station Design

The results of these discussions and the outcome of the studies will guide the Space Station's designers. Only after the needs of the varied users have been clearly defined, carefully analyzed and integrated into the Space Station's design will NASA give the go-ahead to industry to begin building the components.

The preliminary studies offer pertinent clues about the Station's eventual configuration.

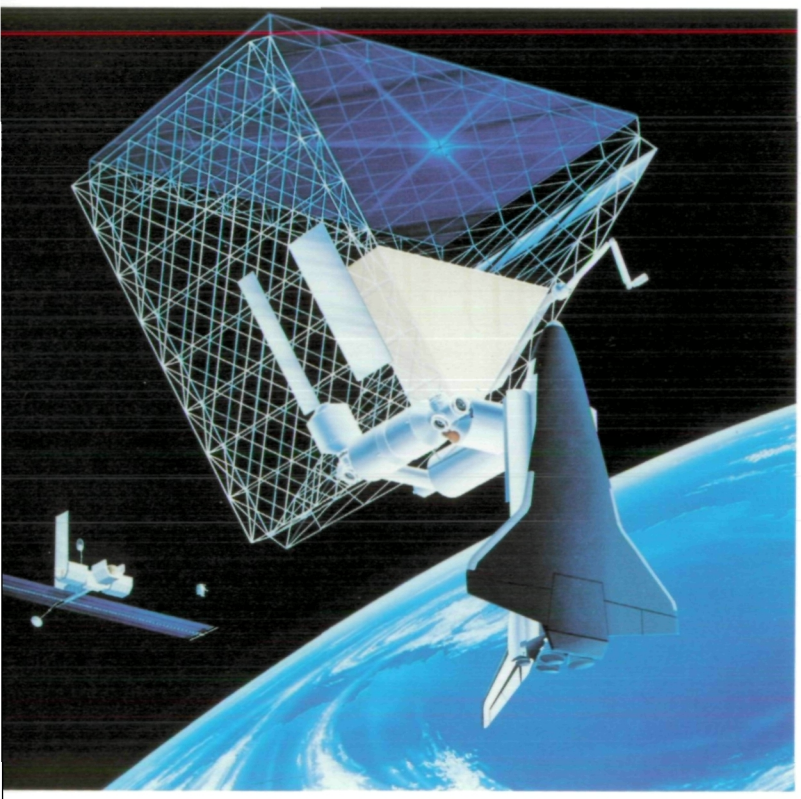
The Space Station must provide a suitable work environment for six to eight men and women. The Station will need ample power supplies for research and operating equipment and for the life support systems. It will need modern data processing and communications systems. It will need at least one docking port to which the Shuttle Orbiter can attach itself to deliver supplies and rotate crews.

### Shuttle Will Deliver Elements

Since all elements of the Station will need to be delivered to orbit in the Shuttle's cargo bay, the Station's components and all subsequent additions must fit into that bay which is 18 meters (60 feet) long and 4.5 meters (15 feet) in diameter. Components which are too large or too heavy for the Shuttle must be delivered in sections and assembled in orbit.

As now foreseen, the crew quarters will be in a cylinder-

*This "Delta" Space Station design was developed by the Johnson Space Center in Houston, Texas. Note docked shuttle in right foreground and unattached scientific platform in nearby orbit in lower left background.*



shaped habitation module about as large as a medium-size house trailer. An almost identical module will be used as a laboratory/work area. Both modules will have an atmosphere like an airplane's passenger cabin.

In orbit the modules will be connected to each other with a tunnel, for ready access. Other modules of the same or different size and shape will house power-generating equipment, supplies and reserve machines.

Protruding like paddles from the sides of the modules, or from beams attached to the modules, will be rectangular panels covered with solar cells for power production. Other panels will contain radiators to dissipate excess heat, generated from Station operations, into the vacuum of space.

Antennas of various sizes and shapes will extend from the modules or the attached beams. Also extending from these beams will be pallets on which will be mounted scientific instruments. The pallets and the free-flying platforms comprise the unmanned sections of the Space Station.

A crew-controlled crane will unload the Orbiter's cargo bay. The crane will also assist astronauts to move equipment during in-orbit construction work and in other exterior operations. The crane resembles a mechanical arm and hand and will likely be an advanced version of the Remote Manipulator System (RMS) developed for use on the Shuttle by Canada.

**Units to Form Unsymmetrical Cluster**

Most drawings and models of the Space Station depict an unsymmetrical cluster of modules, beams, panels, tunnels and antennas along with the associated unmanned scientific platforms. This presents an unusual appearance to anyone not familiar with each element's functions. That strange appearance may be heightened by versions of advanced space stations encompassing additional modules and platforms.

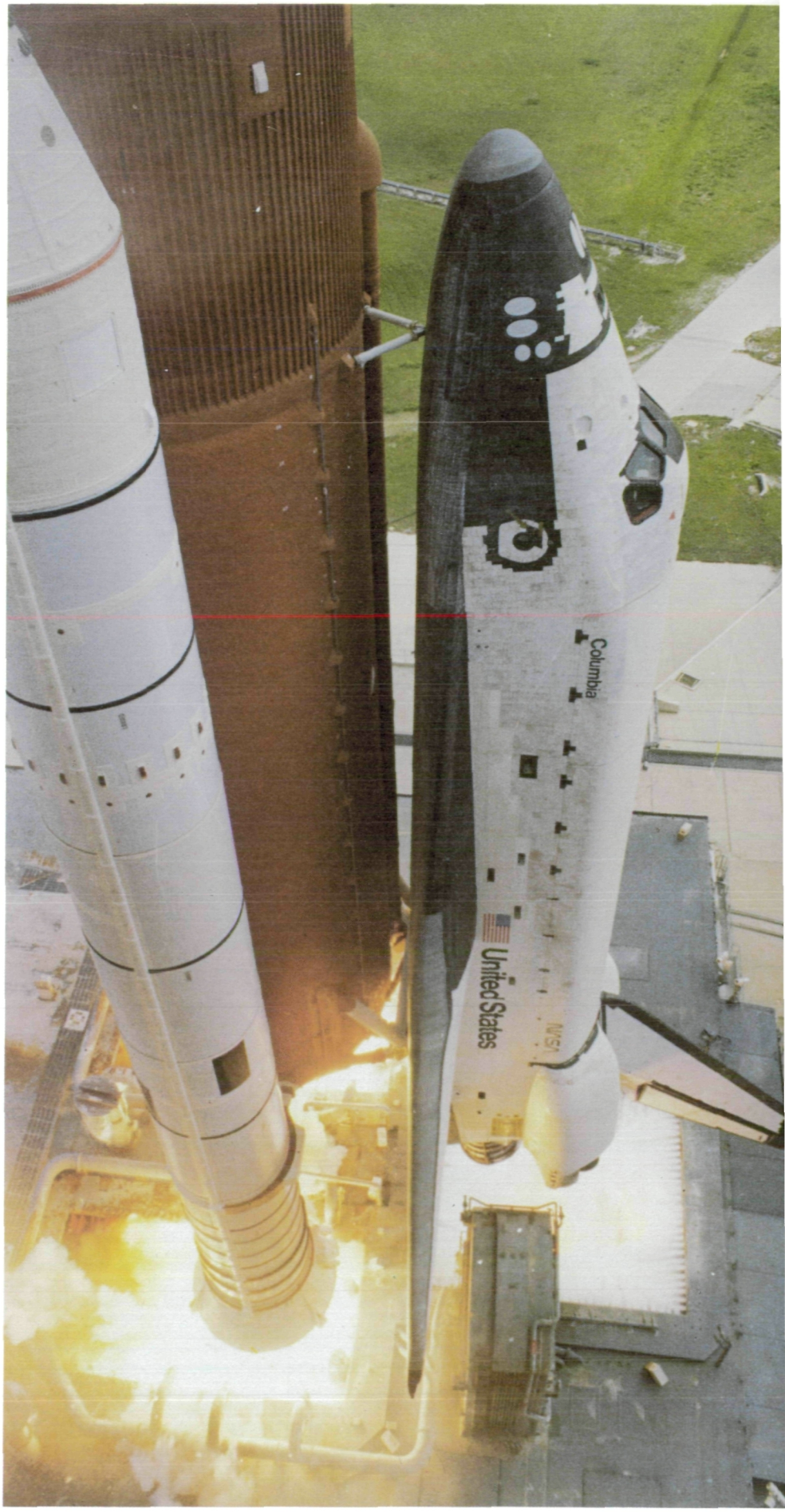
NASA's planning for the number, shape or arrangement of the Space Station's elements will reflect the agency's best thinking on how to make the Space Station as cost-effective and useful as possible.

The Station will be tailor-made for the large variety of instruments and work assignments it will be accommodating. Its wide-ranging tasks can be distilled into a single objective: *To serve our nation's multiple needs in space during the years ahead.*

*The Space Shuttle Challenger rockets to orbit in June of 1983. Astronaut John Young took this photograph above the clouds from the aircraft used to monitor high-altitude weather conditions for Space Shuttle launches.*

# How it Will Work

## The Space Shuttle/ Space Station Partnership




*"T minus six, we have ignition . . . we have lift off."*

**"The Shuttle is a central element of the Space Station endeavor. With both systems operational, the U.S. will have a capability to work in space unmatched by anyone."**

***Philip E. Culbertson, NASA Associate Administrator for Space Station, August 1, 1984***

If it ever could be said that one plus one equals more than two, it would be true of the Space Shuttle plus the Space Station. Meant to complement each other, they will form a natural partnership with exceptional combined abilities.

*The Shuttle* will provide reliable, economic, routine roundtrip transportation for crews and supplies between the Earth and orbit.

*The Space Station* will provide a suitable place where crews can work in orbit for as long as needed.

Together, the Shuttle and the Space Station will comprise a valuable national resource. They will contribute to virtually all major U.S. space projects—manned and unmanned—well into the next century. All manned U.S. space operations—explorations, research and services—will take place in or from the Shuttle or the Space Station. They will be carrier and repair shop for numerous unmanned automated experiments and observations.

In the beginning, the Shuttle will be the transportation for the construction effort rather than a Space Station partner. The Shuttle's Orbiter will carry the Space Station modules and other components into space and park them in orbit. There, the Orbiter's crew will assemble the Space Station. A maneuvering arm or crane in the Orbiter's cargo bay will move floating modules and other components into desired positions. The modules and components will be joined together by astronauts steering themselves like small human spacecraft with gas-powered backpacks called Manned Maneuvering Units (MMUs). Assembling the station will require new tools and new techniques, and will add much to the knowledge of space operations. The crane and MMUs have already been tested during Shuttle flights in 1983 and 1984.

The same or a similar crane and MMUs will be used by later crews for maintenance work and repairs on the Space Station—both its modules and science platforms—and to add or exchange additional components.

### Shuttle to Link Space Station and Earth

Voice and data communications between the Space Station and the Earth will flow over conventional electronic channels, directly or via satellites. But the Space Station's only physical link with the Earth will be the Shuttle's Orbiters. Serving and tending the Space Station will be among the Shuttle's prime tasks.

An Orbiter will perform as both a taxicab and a truck. From its launch site at the Kennedy Space Center in Florida the Orbiter will ferry supplies and replacement crews to the Space Station.

The Orbiter's flight crew—a commander and pilot who are both career astronauts—will guide the Space Shuttle to a rendezvous with the Space Station.

After unloading the cargo and exchanging all or part of the Space Station crew, the Orbiter will take on completed experiments and products manufactured aboard the Space Station. Then the Orbiter will leave the Station, reenter the atmosphere and glide to a landing on the Kennedy Center runway.

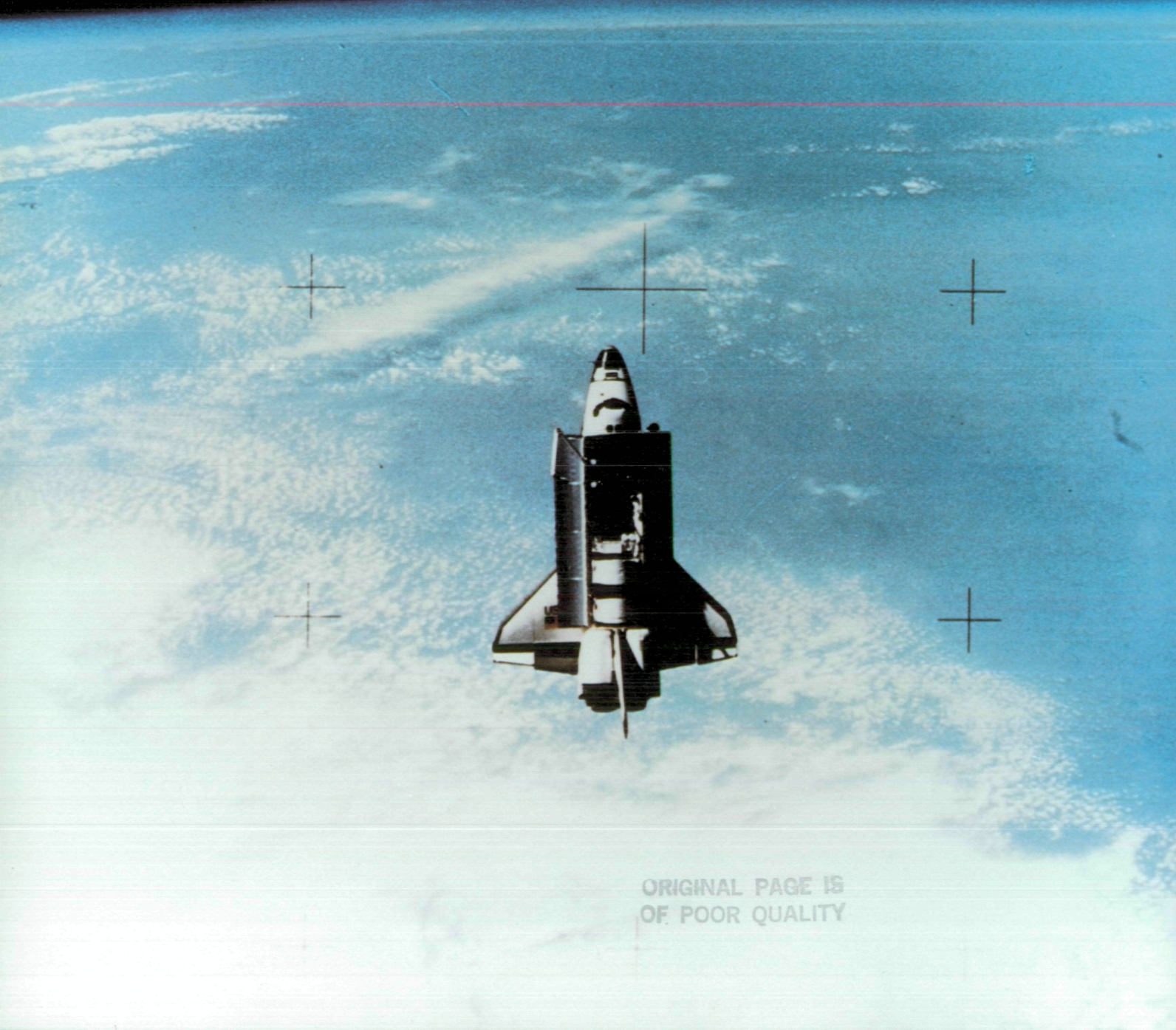
By the late 1990's Orbiter trips to and from the Space Station will have become commonplace—no more noteworthy

than the departure and arrival today of ships and trains.

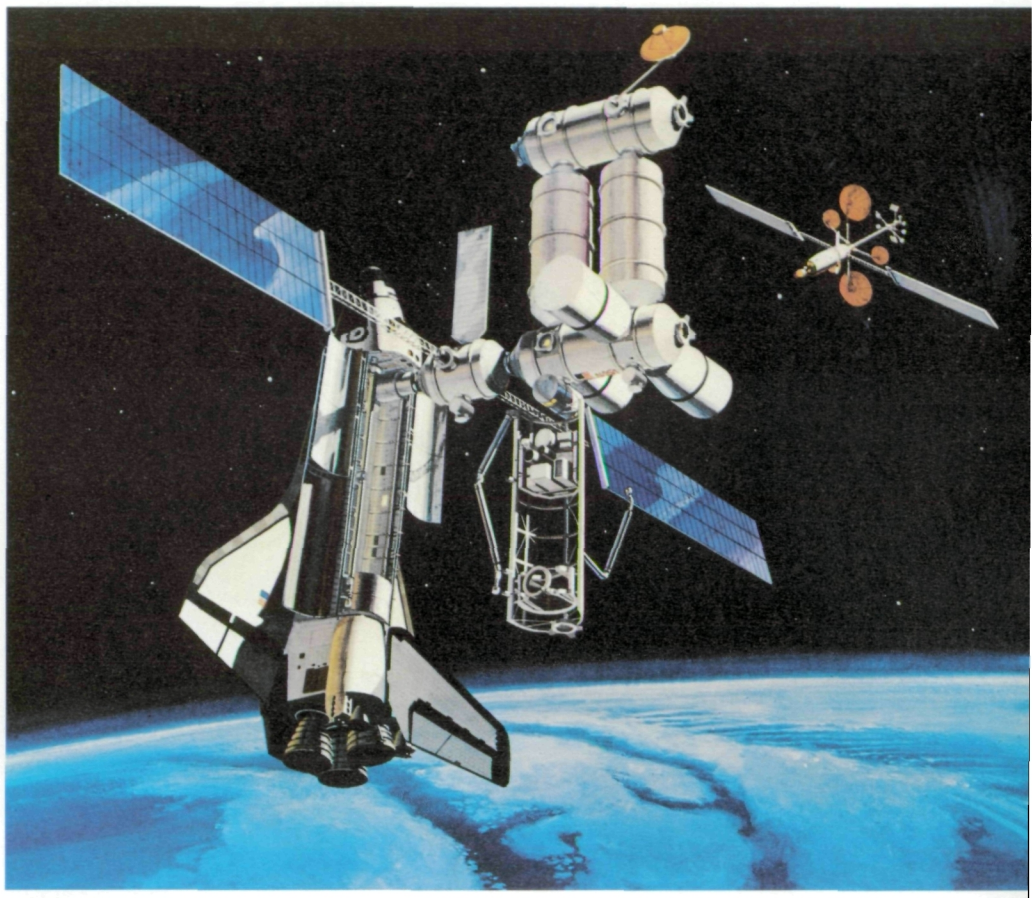
The headlines will be made, not by routine launches and landings, but by research and other pioneer activities aboard the Space Station. This will be work which cannot be done on the Earth—manufacturing and research requiring near-weightlessness, or the picture-window panorama of the Earth, or the above-the-atmosphere view of the solar system and the universe.

A key purpose of the Space Station is to enable scientists and technicians, in conjunction with automated instruments, to use the vantage point of Earth orbit and the environment of space for as long as needed.

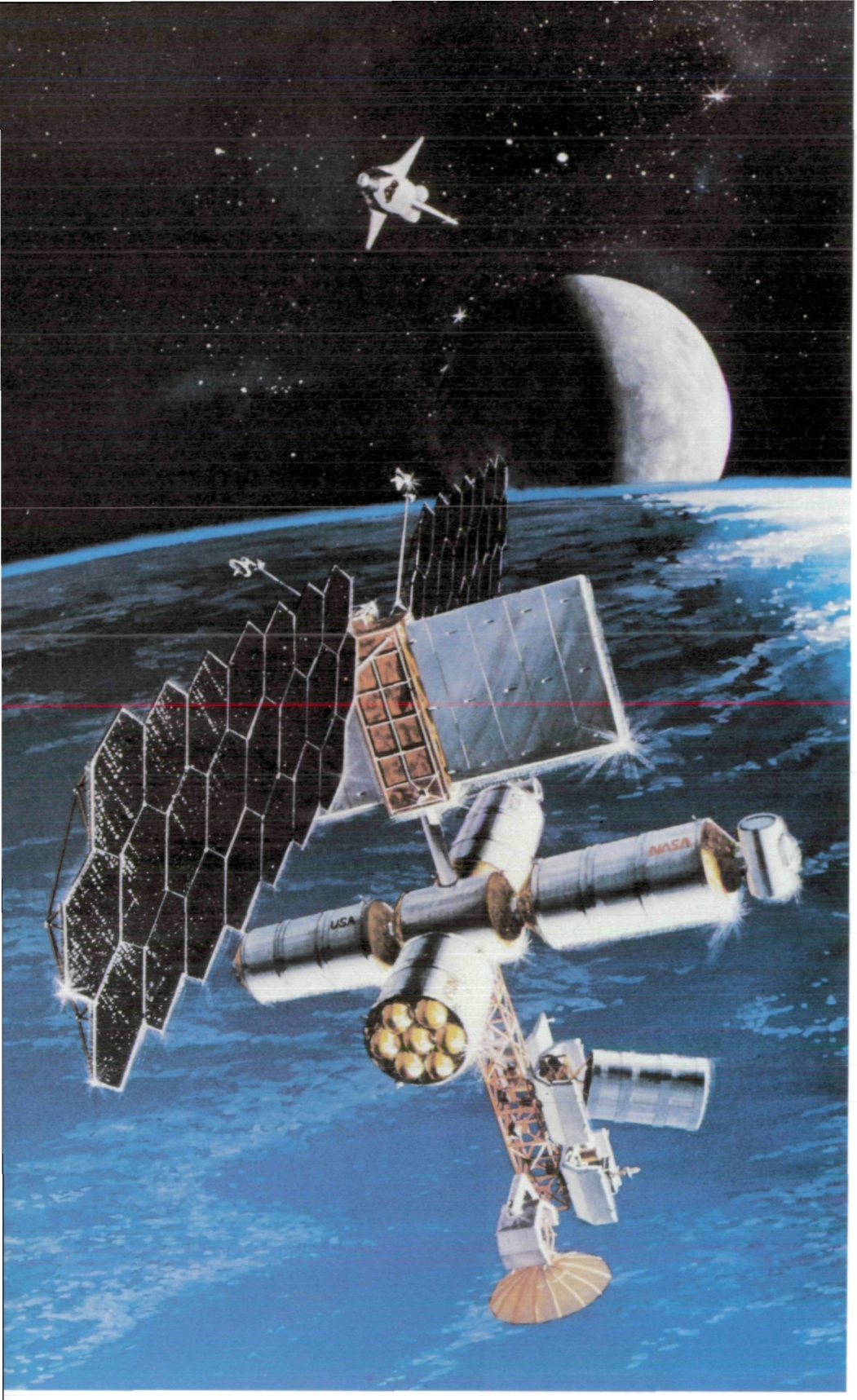
*The Space Shuttle assures United States leadership in space during the decade of the 1980's. The Space Station will maintain that leadership in the 1990's and beyond.*



*When the Space Shuttle was conceived late in the 1960's, a Space Station was envisioned as a natural complement, a place for the orbiter to shuttle to. Now that the Shuttle is approaching operational maturity the Station becomes a logical next step. The photograph to the left shows what the Shuttle might look like from the Station as it approaches for a rendezvous. The picture at the right illustrates a Shuttle orbiter docked to a Station from which an advanced communications satellite has been deployed.*



*Astronaut Guy Bluford participates in a treadmill medical test during the September, 1983 Space Shuttle mission. Man's ability to live and work in space makes feasible a permanently manned presence in the low-gravity environment of space.*

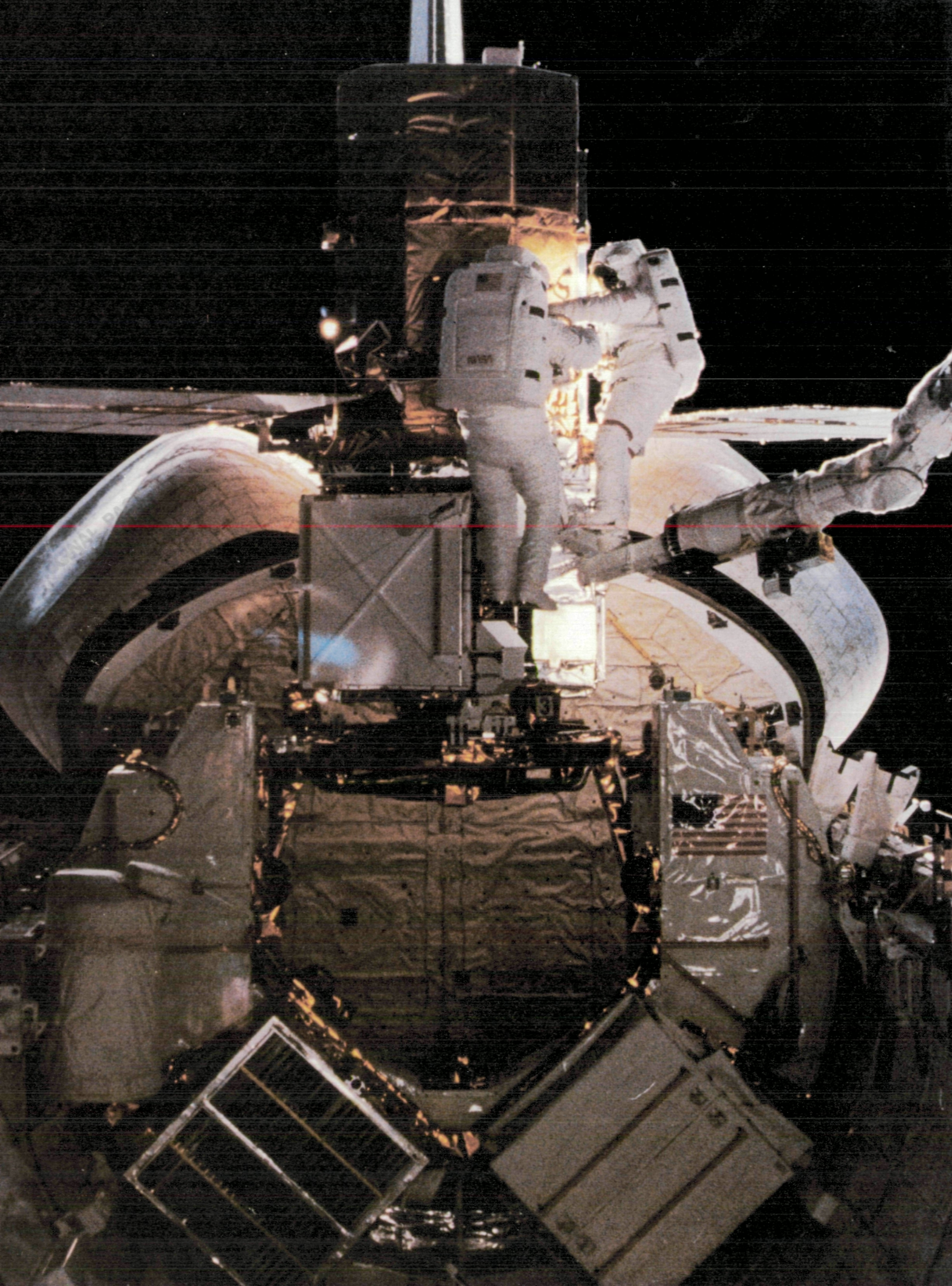



*The Space Station concept illustrated here shows modular sections extending from a central core. Advanced-technology solar panels and a structural truss carrying unmanned scientific experiments are featured in this configuration developed by the TRW Space and Technology Group of Redondo Beach, California.*

*The Space Shuttle, seen here landing at Edwards Air Force base, will carry aloft the various Space Station elements. It will help on-orbit, and will be the Space Station logistics vehicle transporting crews, supplies and payloads.*

*While allowing equipment to float weightlessly in front of him, astronaut Joseph P. Allen prepares to take some photographs from the Space Shuttle's flight deck. Space offers a unique vantage point from which to photograph the Earth below and the stars above. The Space Station will support long-duration observations and provide the capability for maintenance and repair when necessary.*





# An Enduring Space Laboratory

## A Powerful New Tool for Science

**"Our experience in space tells us that some tasks are best performed by automated equipment and that other tasks require the unique capabilities of man.**

**Tasks that are routine and which can be preprogrammed tend to be best performed by machines. Tasks that require initiative and judgment are more suitable for man. The Space Station will have plenty of both kinds."**

***John D. Hodge, Director, NASA Space Station Task Force***

Astronauts at Work: *George Nelson and James van Hoften repair the Solar Max satellite in the cargo bay of the orbiter Challenger. The satellite was later redeployed and placed back in operation. Maintenance and repair like this can keep valuable scientific satellites functioning for long periods of time and will be an important task for the Space Station.*

The Space Station promises to become one of the most powerful investigative tools ever to come into use by scientists. Like the microscope and the computer and other milestone research instruments, the Space Station will open new windows in science.

Spacecraft have already vastly expanded scientific frontiers in the last 25 years. They have revolutionized the ancient discipline of astronomy. The ability to make observations from above the obscuring atmosphere and to use automated and remote-controlled probes for close-up inspections of the planets and their moons has opened a new era of solar system and cosmological exploration.

Planets which were pinpoints of light to the unaided eye and whose features were only dimly discernible with the best telescopes have, in recent years, been seen and measured through space probes. To the spacecraft lens they appear as giant worlds with characteristics peculiarly their own.

Astronaut exposures to low gravity and other unique stresses in space have made possible fascinating studies in the life sciences. The findings are providing valuable information in the fields of medicine and health sciences. Experiments in prolonged low gravity with many different materials are contributing to a better understanding of metals processing, chemistry and the handling of fluids. The Earth sciences have benefited from visual and electronic examinations of lands and oceans from the panoramic perspective available only from space.

### A Permanent Presence In Space

All of this and more has been accomplished despite the limitations past space exploration systems have imposed on researchers. Experiments which may have taken years to prepare had to be compressed into a few days or hours if they required human participation in space. If they were unmanned automated experiments, they had to be failure-proof, for once launched they were no longer accessible for maintenance and repair.

The continuous presence of six to eight specialists in

the Space Station will profoundly change the research environment.

Experiments requiring on-site monitoring and adjustment over very long periods—weeks or months or even years—can be operated without interruption in the Space Station. No longer do experiments need to be returned to Earth at the end of a mission and then prepared for reflights. If an instrument generates doubtful or spurious data it can be tested on-site by crew members who can then take immediate corrective action based on their judgment and experience. Because of the Space Station's size large quantities of support equipment and other resources can be kept there readily available to the crew.

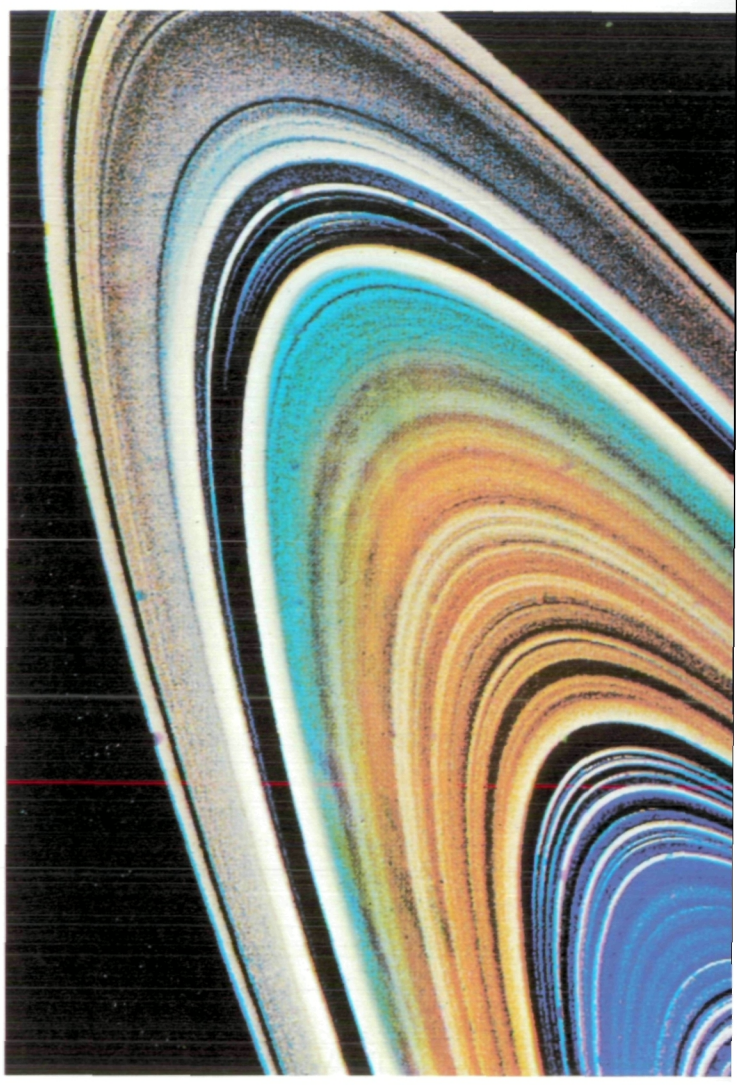
If desired, the crew can consult with colleagues on the ground using radio and television. Such exchanges, called *interactive research*, between scientists on the Earth and specialists in space frequently took place during the first flight of Spacelab, the European-built orbital laboratory which operated aboard the Shuttle in 1983. Similarly, scientists on the Earth closely followed the excursions on the Moon by astronauts during Apollo missions in the late 1960s and early 1970s.

All experiments on board the Space Station can expect to benefit from the availability of crew members for maintenance, adjustment and repairs. Even the instruments on the unmanned pallets and free-flying platforms can be reached when necessary, either by crew members wearing space suits and MMUs, or in the case of the associated unmanned platforms by propelling the satellite back to the station.

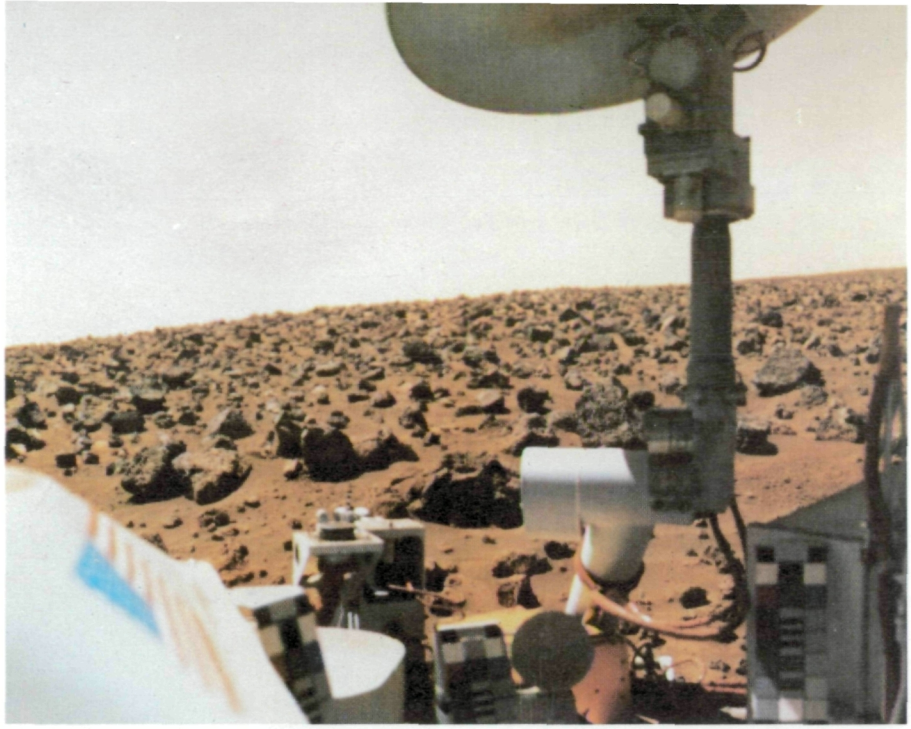
### Manned and Automated Functions Planned

The advantages of having both manned and unmanned facilities aboard a spacecraft have become obvious over the years. Automated instruments can save substantial time and energy for the crew. The specialists can then direct their attention to tasks which machines cannot perform. The value of a crew has been illustrated dramatically when unexpected events have occurred.

For example, in the early 1970s a crew of three astronauts patched and mended some of the damaged portions of Skylab. The damage occurred after a mishap, during Skylab's unmanned launch. Skylab achieved orbit—overheated, underpowered and uninhabitable. Subsequently, after extensive repairs, this crew and two other crews lived and worked successively in Skylab for periods of several weeks to nearly three months. They brought back a rich harvest of research results.



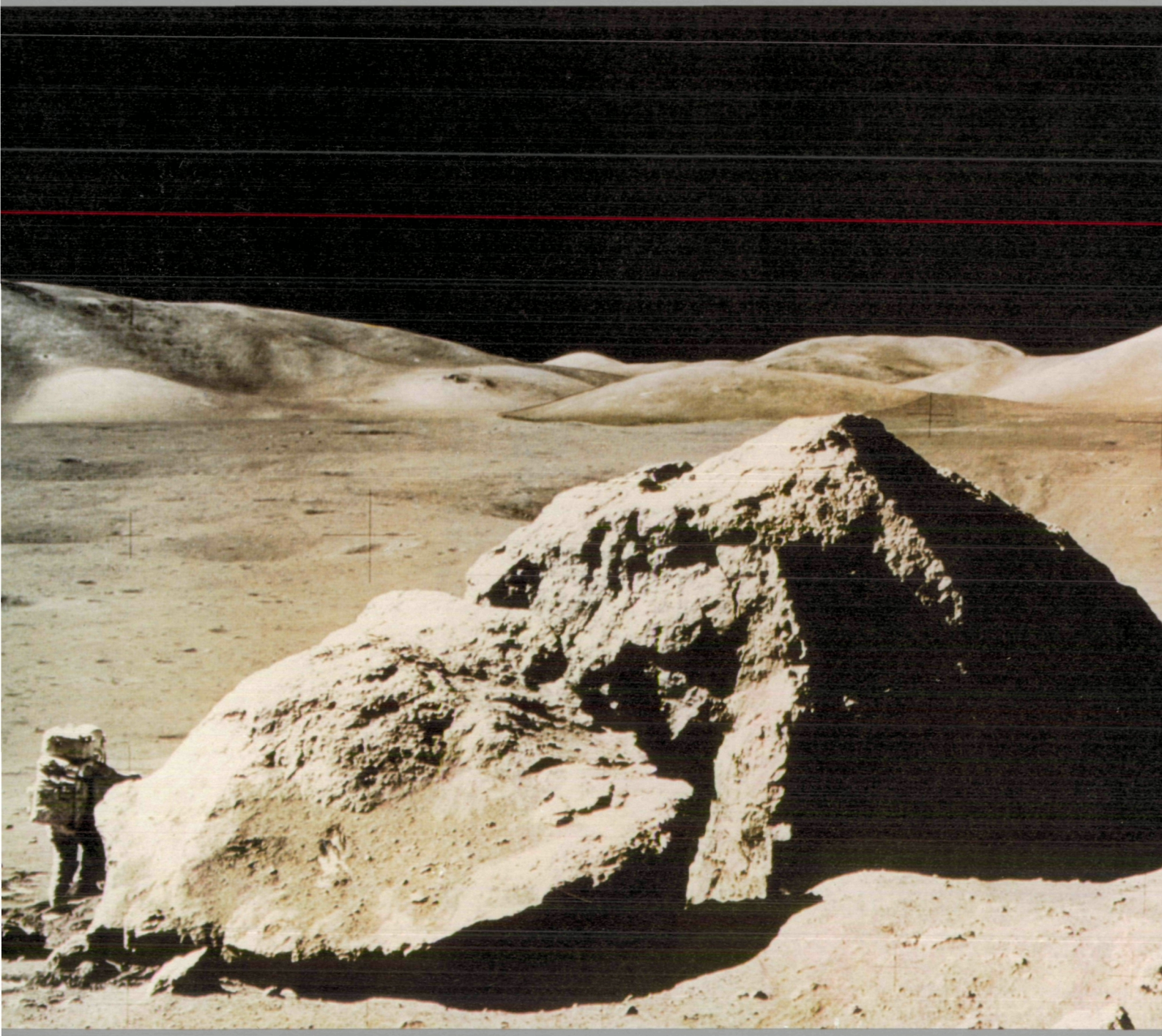
*This Voyager 2 picture of Saturn's rings shows color variations which may be due to differences in chemical composition. Space science has been a major thrust of NASA activities to date and will continue to be so during the 1990's when the Space Station is operational.*

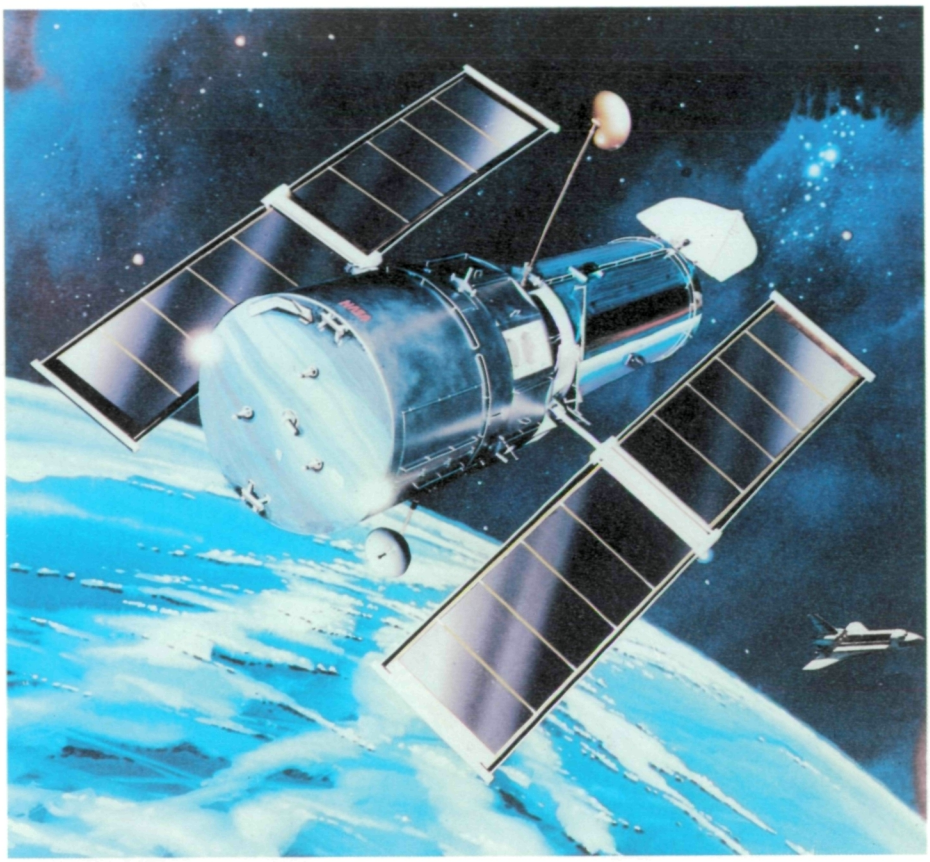


*The volcano on Io, one of Jupiter's moons; the rings of Saturn and the reddish surface of Mars have become familiar sights from pictures like these returned from Voyager and Viking spacecraft. Planetary spacecraft of the future may be checked out on and deployed from the Space Station.*

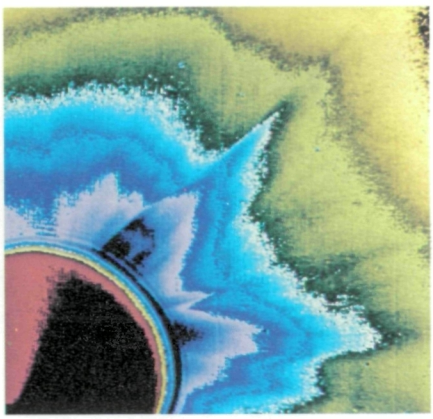
ORIGINAL PAGE
COLOR PHOTOGRAPH

*Apollo 17 astronaut Harrison Schmitt, a geologist by training, explores the Taurus-Littrow Valley on the Moon. Greater scientific understanding of the Moon was a principal objective of the Apollo lunar missions.*





*The Space Telescope, to be launched by the Shuttle in 1986, will be a scientific instrument of historic significance for, unlike most previous telescopes, it will scan the universe free from the obscuring effects of the atmosphere. The Space Telescope is designed for on-orbit maintenance and repair. Such satellite servicing will be a primary function of the Space Station.*



*This view of the Sun's outer envelope, the solar corona, was prepared from observations provided by the Solar Max satellite. This satellite later malfunctioned and was repaired by astronauts aboard the Space Shuttle, confirming again the value of a human presence in space.*

In April 1984 a Shuttle crew retrieved and repaired the Solar Maximum Mission satellite, which was no longer able to point its instruments precisely at the desired regions of the Sun. The satellite got its name from its assignment to observe the Sun during its most active period—the solar maximum—of Sun spots and flares in the 11-year solar cycle. Shuttle astronauts replaced and repaired the craft's attitude control system and one of its scientific instruments while in orbit. Such repairs in space cost far less than the replacement of the entire satellite.

**Space Telescope to Need Tending**

Periodic maintenance will be essential for the orbiting Space Telescope to be launched by the Shuttle in 1986. That instrument will be kept in operation for many years and will require occasional servicing by visiting astronauts.

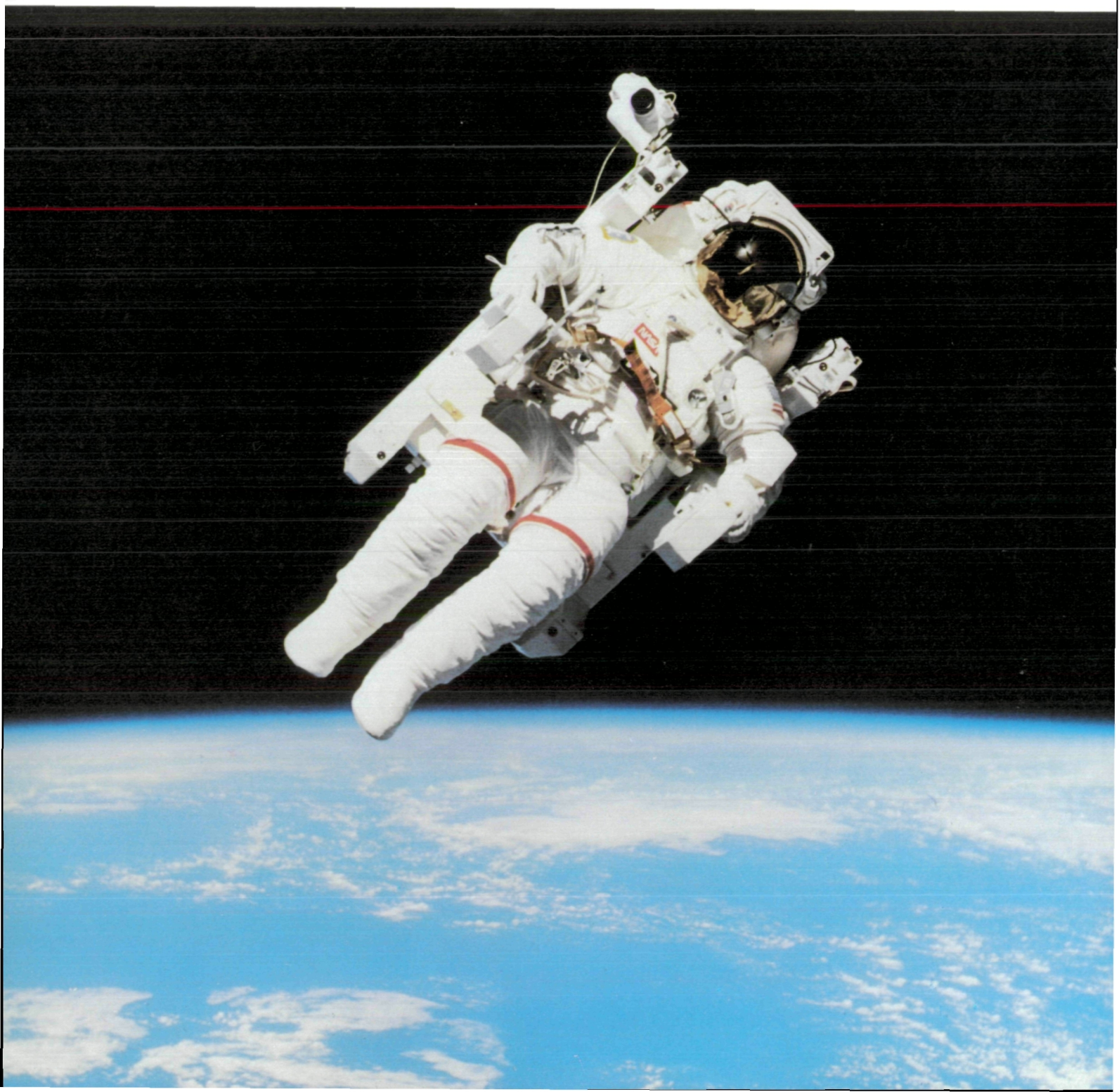
The telescope will look back in time, viewing light radiations from the edge of the universe that have been traveling at the speed of light for billions of years. Its optics will see objects 50 times fainter than today's best astronomical instruments.

With its combination of manned and unmanned facilities, the Space Station will unveil new opportunities for scientific experiments and explorations. To foster these opportunities is part of NASA's continuing commitment to the advancement of science.

# Commerce in Space



## Industry Setting Up Shop in Space



A sizeable commercial enterprise has blossomed in the vacuum of space. It provides services of high quality at reasonable prices for the public, highly-paid skilled jobs for workers, and dividends for investors.

In less than 25 years space communications have grown from an idea into a flourishing industry. Annual revenues total more than $2 billion. Many Americans are employed designing, building and operating communication satellites. The number of these satellites is expected to increase more than threefold from the present 80, to perhaps 300 in the next 15 years.

The satellites are satisfying burgeoning global needs. They are introducing instantaneous modern communications in remote areas of developing nations, where installing conventional services might have required decades. They are augmenting overloaded or outdated circuits in technologically advanced nations, where new channels for modern data transmissions are being provided.

Satellite technology has come a long way since SCORE, the world's first communications satellite, was launched by the United States and began transmitting taped messages in December 1958. Today's satellites simultaneously carry thousands of two-way voice transmissions plus data and television channels. The ease and quality of transcontinental and transoceanic telephone calls has improved. Costs to consumers have gone down or held firm even in inflationary times. The communications satellite industry has dramatically demonstrated that private enterprise can work well in space.

**Companies Seek Ventures in Space**

Repeated experiments in Apollo, Skylab and Shuttle flights have shown that, amid prolonged minimal gravity, materials can be imbued with unique and valuable properties unobtainable on the Earth. These made-in-space materials could make possible new kinds of medicines for fighting diseases, components for vastly improved electronic equipment and other products for profitable sale to industries and consumers. Markets for such products could be immense both at home and abroad. New industries and service businesses may develop. New jobs and a strengthened posture for our nation in international commerce could follow.

Space is seen by many knowledgeable observers as the next big industrial frontier. Potential foreign competitors are experimenting in all areas of space commercialization.

Despite this outlook private entrepreneurs have, until recently, been reluctant to make large investments in space research. With the exception of the communication satellite business and some other isolated projects, there have been few large investments in the commercial use of space. Though eventual payoffs seemed possible, the risks were considered

**"With firm resolve and the commitment of reasonable resources over a number of years, Government and private enterprise working together can turn space into an arena of immense benefit for our nation."**

***L. J. Evans, Jr., Director, NASA Space Commercialization Task Force***

**"The infrastructure we will build will be no different than those we established to meet the great goals of earlier years. We established publicly-funded programs to support development of our highways, airports and railroads. The proposal to do the same for space will enable the commercial sector to work in partnership with government to open the realm of space to any number of promising enterprises."**

***James M. Beggs, NASA Administrator, at the White House briefing, January 26, 1984***

*Astronauts steering themselves with a Manned Maneuvering Unit (MMU) in untethered free flight will be an important element of Space Station operations, including those operations devoted to the private sector.*


ORIGINAL PAGE
COLOR PHOTOGRAPH

*The size and complexity of advanced communications satellites is exemplified by the Tracking and Data Relay Satellite (TDRS) shown here being inspected prior to launch at the Kennedy Space Center. NASA uses the TDRS for communicating with spacecraft, having been able to phase out some of its ground-based tracking and data relay stations. The Space Station will be designed to be compatible with TDRS.*

too great for private undertakings. Investments required for research or manufacturing facilities in space are considerable. No precedents existed to serve as guidelines for large-scale commercial research and manufacturing in space, for the transportation of raw materials and finished products—or for the distribution and marketing of these products. Today, there are signs that the situation is changing. Several companies have come to NASA to discuss possibilities for new commerical ventures in space.

**Dependable Space Access is Prime Need**

The commercial utilization of space will depend upon the availability of regular, reliable, cost-effective access to orbit and a suitable place to work once there. It will depend also upon research and repair facilities being available to the private sector.

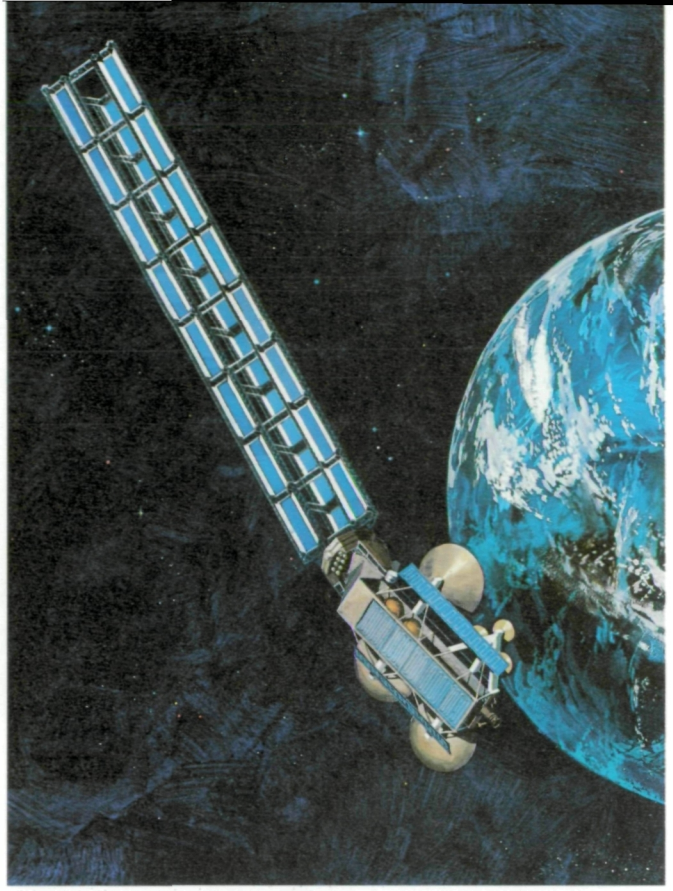
Dependable and relatively inexpensive roundtrip transportation to orbit is now becoming available with the Shuttle system approaching maturity. The Shuttle fleet of four Orbiters offers improved access to orbit for cargoes and crews. Some important commercial space manufacturing projects are expected to develop perhaps as early as the last half of the 1980s.

Availability of a continuing work place in orbit, as well as availability of permanent maintenance and repair equipment there, must await the completion of the Space Station. Thus, in the view of many, the Space Station holds the key to eventual large-scale commercial space operations.

**NASA Offers Joint Endeavor Agreements**

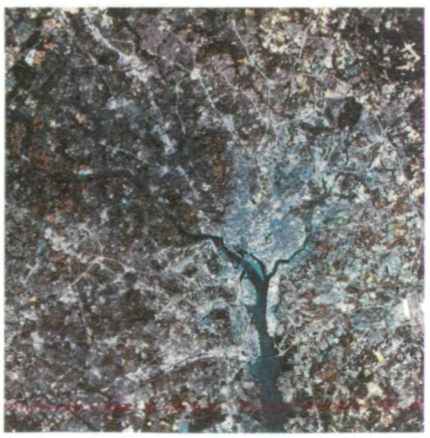
In the meantime, to encourage and ease the entrance of private enterprise into commercial space activities, NASA has offered to participate in Joint Endeavor Agreements (JEAs) with companies willing to invest in space research. Under JEAs, NASA helps reduce the risks of investing in space. Flight opportunities on the Shuttle can be provided at reduced rates. In addition, JEAs also allow these firms access to relevant NASA research information and research facilities and a limited exclusive private ownership of technologies developed by these firms through their own research.

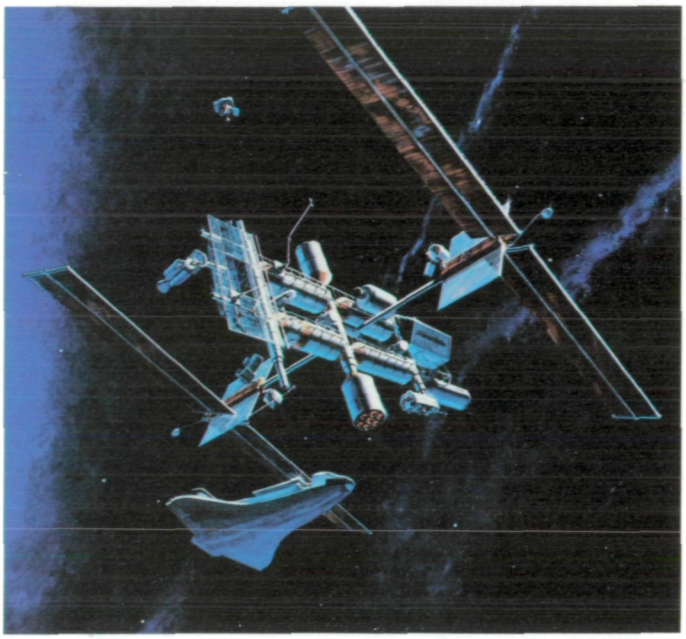
Current research under JEAs centers on the separation of biological substances in low gravity for the production of



*Large structures in space become feasible with a Space Station for the station enables such structures to be assembled and checked out in space. Shown here is an artist's conception of a solar power satellite.*

*Landsat Imagery—The different energy levels emitted from the various surfaces of the Earth are measured and then "pictured" by NOAA-operated Landsat satellites. Commercial operations of such satellites is now under review. Shown in this image is Washington, DC.*





*This Space Station concept features twin sets of solar panels for the generation of power and of radiators (the rectangular shapes perpendicular to the plane of the larger solar panels) for the dissipation of waste heat. This concept also shows two orbital transfer vehicles (OTV's)—rockets for carrying payloads to higher energy orbits—based at the station, as well as a smaller Orbital Maneuvering Vehicle (OMV) on its way to a nearby satellite. The Space Station will serve in the future as a transportation node, and staging point for missions to geosynchronous orbit and to other planets.*

drugs with far greater purity than can be obtained on the Earth. The Shuttle on-board research involves the processing of enzymes and hormones. Among several dozen marketable items that may emerge in the next several years are insulin and interferon with unprecedentedly high qualities. These and other medical products made in space may lend themselves to new approaches for fighting diabetes, cancer, emphysema, hemophilia and other diseases.

Research in low gravity with promising commercial possibilities has focused on the growth of crystals and electronic components with greater uniformity and purity than can be produced on Earth. They may lend themselves to the design of faster and more intelligent computers. These may also lead to new kinds of communications systems for global dissemination of information and for enhancing educational systems.

**Improved Metal Alloys Sought**

Other space research takes advantage of low gravity to uniformly mix metals of very different weights. On the Earth the heavier components sink to the bottom of the container before the mixture can cool and solidify. Still other research is expected to yield information about processes and properties that will help us improve our research and manufacturing here on Earth.

New alloys may become possible with valuable qualities such as greater strength and lower weight than any presently available. Still other experiments in the materials sciences examine the possibilities of contamination-free containerless processing by allowing molten materials to float in a vacuum in zero-gravity without touching any container walls until they are cooled and hardened.

The entrance of free enterprise into space follows our national traditions. It also conforms to national policy. President Reagan, in restating the goals and objectives of the U.S. space program, has promised that the Federal Government will provide a climate conducive to expanded private sector investment and involvement in civil space activities.

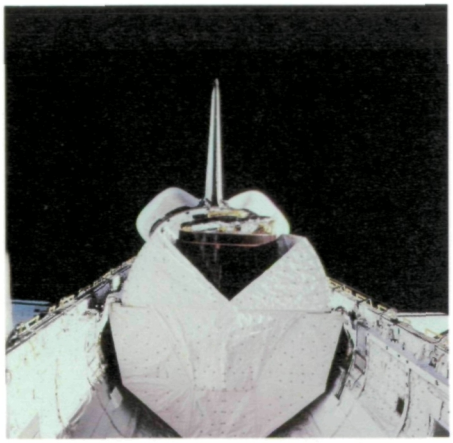
Private initiative has been the foundation of our nation's development and progress from its beginning. During the earliest explorations of the North American continent explorers and pioneers were followed by traders and craftsmen who came to serve the new settlements. In the closing years of the 20th century, industrial entrepreneurs will follow our astronauts into the newly accessible realm of space.

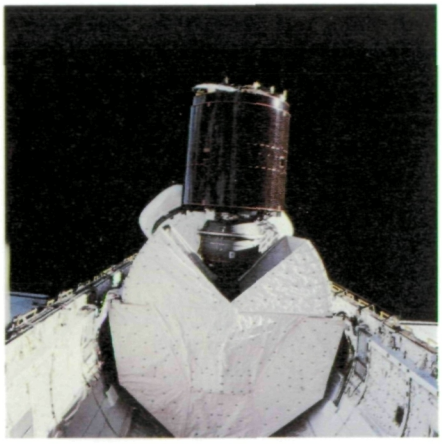


*In this configuration the solar arrays that provide power to the Space Station are placed atop a rigid T-shaped structure. Commercial operations at the Station will require significant quantities of power.*

*This sequence of photographs shows the Space Shuttle's November 1982 deployment of Satellite Business System's communications satellite SBS-3. Commercial endeavors in space, like this one, are expected to expand in the era of the Space Station.*








*McDonnell Douglas astronaut Charles Walker is shown here with equipment of the Electrophoresis Operations in Space program, a private venture of Ortho Pharmaceuticals and McDonnell Douglas. The program utilizes the microgravity environment of space for the development and eventual commercial production of biological materials suitable for health care.*

# Why a Space Station Now?

## Our Step-by-Step Climb Into Space

The space revolution that began in the late 1950s was really no "revolution" at all. It was the natural outgrowth of the steady evolution of science and technology. Since then exploration of space and the development of space technology have continued with that same evolutionary advancement. Each generation of U.S. spacecraft has been technologically superior to earlier ones. Each expanded our abilities. Each added to our proficiency for drawing dividends from the space environment. The Space Station continues that trend.

In the chain of development of the U.S. manned space program, the permanent Space Station will become the seventh type of space vehicle. It represents the next rung on the ladder the United States must ascend if it is to retain its leadership among spacefaring nations.

The notion of a Space Station is not new or revolutionary. Nor does it represent any sudden breakthrough. In the early 1970s the United States achieved valuable experience with a temporary space station called Skylab. The Soviet Union has for several years operated several versions of a temporary, relatively small space station called *Salyut.* Cosmonauts, living and working in Salyut continuously for periods of up to seven months, have conducted scientific experiments and repaired equipment.

### Space Station—A Step in Orderly Development

The concept for the permanent Space Station emerged from the systematic progression of manned orbital activities stretching over a period of more than 23 years.

U.S. manned space flights began in 1961 with the one-man Mercury spacecraft. Next came the two-man Gemini spacecraft. It completed 10 flights within 20 months in 1965 and 1966. Each crew's living space was only equal to the area occupied by a driver and a passenger in the front seat of a compact car. Mercury astronauts had even less space. Still, one Gemini crew managed to extend stay-time in orbit to within a few hours of two weeks, a world's record that stood for 5½ years.

Project Gemini taught astronauts to steer their craft into different orbits during flight so that they could rendezvous and dock with other spacecraft.

The third generation of U.S. manned space vehicles, Apollo, was a three-man spacecraft primarily designed to transport men to the Moon and back. It has about as much room inside as a large station wagon or a small van. Astronauts could take off their space suits during flight and stand up and move around.

From 1968 through 1972 the Apollo spacecraft completed two Earth-orbital flights (to test the system), three around-the-Moon flights and six highly successful manned Moon landing missions.

As part of the Apollo project engineers built a fourth kind of manned spacecraft, a space ferry called the Lunar Module, or LM (pronounced *LEM).* Its purpose was to transport two astronauts from the Apollo spacecraft in lunar orbit down to the surface and then back. The odd shaped LM performed flawlessly in all of the manned Moon landings.

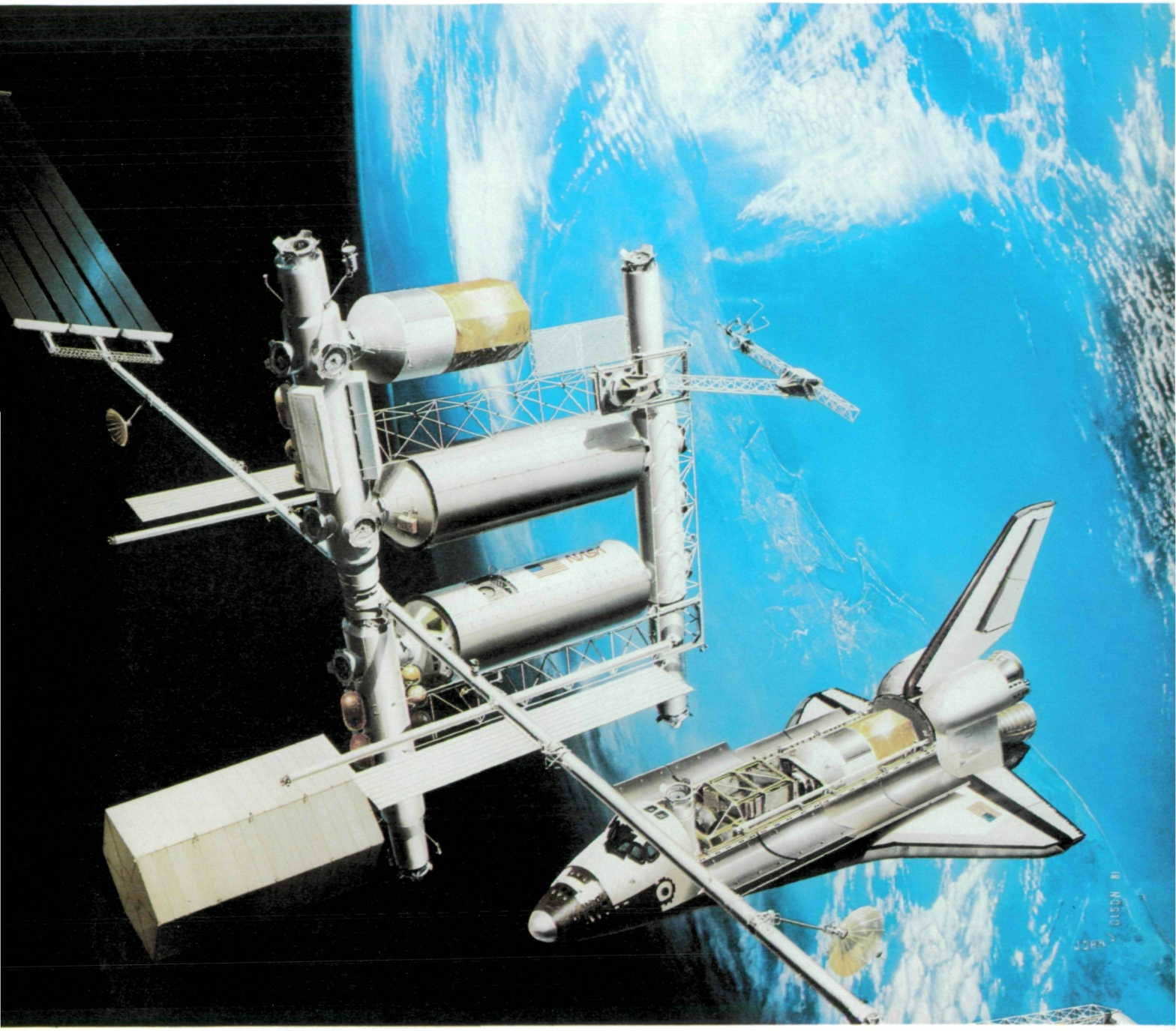
The Apollo system was also used in July 1975 for the Apollo Soyuz program. The Apollo spacecraft linked in orbit with a Soviet two-man Soyuz spacecraft. Using both craft, the five men in the two crews carried out several joint scientific experiments. They also visited each other by crawling through a tunnel connecting the two spacecraft in history's first international manned space flight.

### Skylab: Our First Space Station

Apollo also became the transportation link with Skylab, America's first space station, in 1973 and 1974. The 100-ton Skylab, as big as a small three-bedroom house, was by far the largest U.S. spacecraft, though not designed to return to Earth intact.

Skylab was a bonanza for scientists. The crews brought back with them nearly 300,000 photographs of the Sun as it had never before been seen from above the atmosphere, 40,000 pictures of the Earth and 230,000 feet of magnetic tape containing Earth observation data from orbit.

The crews also brought back hundreds of blood samples



*The Johnson Space Center in Houston, Texas, developed this Space Station configuration as part of the preliminary analysis that led to the President's decision to have NASA proceed with the development of a permanently manned Space Station.*

**"Exploration really is the essence of the human spirit, and to pause, to falter, to turn back on the quest for knowledge is to perish."**

***Astronaut Frank Borman, Commander of Apollo 8, the first flight by humans around the Moon, in address to the U.S. Congress, January 9, 1969, 13 days after returning to Earth.***

*The First Step: Project Mercury. Here Astronaut Alan Shepard begins his May, 1961 15½ minute suborbital flight, the first time an American astronaut flew in space.*


*Based upon Apollo-era technology and hardware, Skylab was America's first Space Station. A valuable precursor to the Space Station program now underway, Skylab showed that individuals could live and work in space over a period of time, could undertake on-orbit maintenance and repair activities and could conduct worthwhile scientific experiments.*

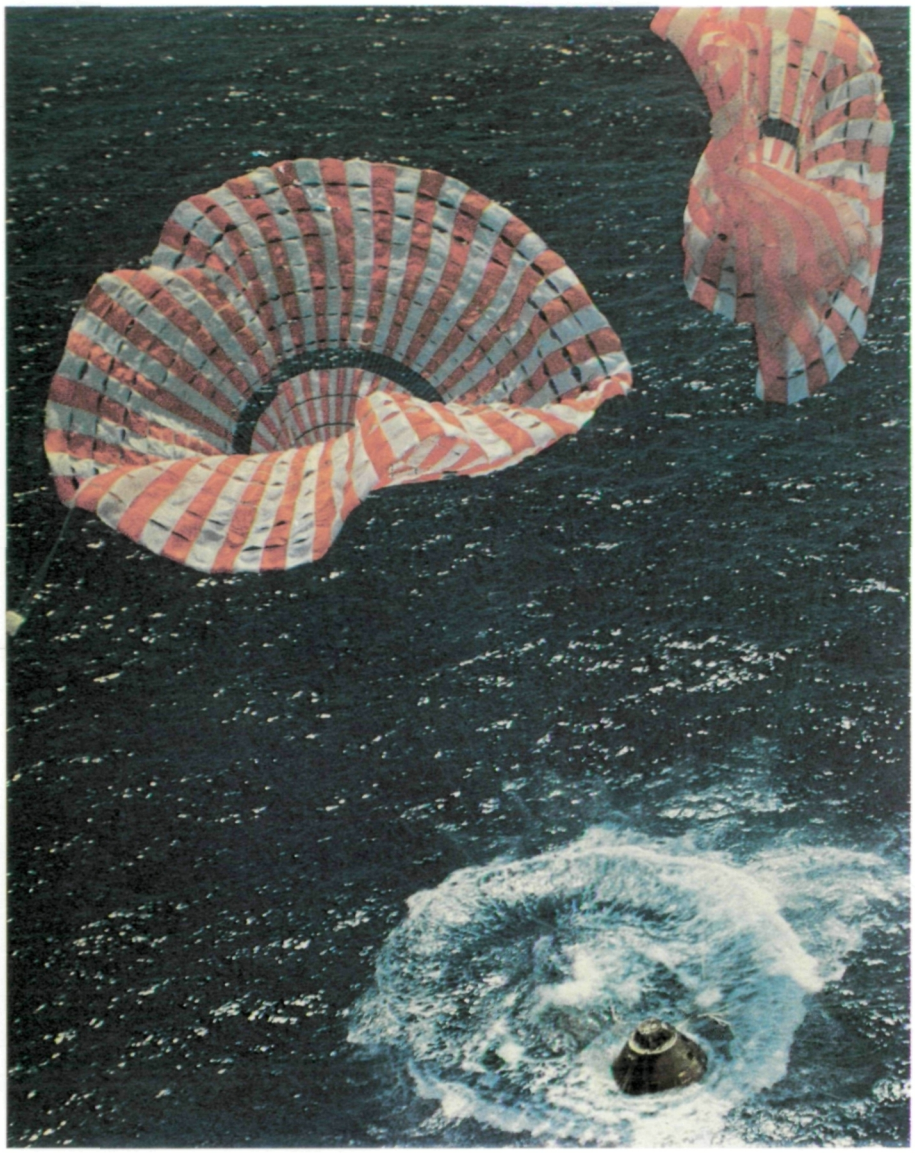


and other biological specimens taken from themselves for examination on Earth to learn about the effects of prolonged weightlessness on the human system.

Skylab provided Americans with their first real experience in long-term housekeeping in space. Engineers and other specialists learned what kinds of furnishings and foods are most suitable for space stations; how humans can keep fit by counteracting the adverse effects of the near-absence of gravity; and how to best carry out scientific research and other work in this unaccustomed environment. All of this experience will prove valuable for the design of the Space Station.

Supplying Skylab was difficult and expensive. Crews and materials had to be carried up to it and returned from it in the relatively small Apollo spacecraft limited to one-time use. Like all spacecraft before the introduction of the Space Shuttle in 1981, Apollo had to reenter the lower atmosphere supported by parachutes, which further limited its weight-carrying abilities. These limitations were overcome with the arrival of the Shuttle.

The Space Shuttle truly will become the space exploration equivalent of the covered wagons that helped pioneers



*Splashdown. The Apollo 15 capsule returns to Earth concluding America's fifth manned lunar mission. The reusable Space Shuttle makes such water landings unnecessary and obsolete.*

open the American West. The Shuttle's reusability, cargo capacity, low-stress launches, highly sophisticated in-flight facilities and smooth runway landings moved NASA space operations to their present maturity.

Its present maximum stay-time in orbit of up to about nine days may well increase perhaps to two weeks. Even then the Shuttle will still be in somewhat the same situation as the office worker compelled to carry a desk and chair home each afternoon and then to return them to the office the next morning. At present everything needed in orbit (except satellites launched from the Shuttle or intercepted in orbit for repair)—must be carried into orbit on every flight and brought back again, only to be launched all over again if needed on another flight.

### A Permanent Presence in Space

The practicality and economics of having equipment in orbit for as long as needed become obvious. With the outlook for larger and heavier machines entering space for research and commercial activities, the advantages of a Space Station become apparent. The period during which equipment will be used in space will be determined by the needs of the experiment rather than by the time available on a short mission.

Advantages also accrue to the unmanned space program. On-orbit checkout of science or applications satellites before their release into orbit and the availability of in-space maintenance and repair can substantially prolong their lives.

In solar system explorations, U.S. deep-space probes have already made flyby and closeup inspections of each of the five planets nearest the Earth. Spacecraft already en route are expected to add two more plants (Uranus and Neptune) to that list in the next five years. If these spacecraft succeed, every planet, except Pluto, the smallest, will have been visited by a U.S. flyby, orbiter or lander before the end of the 1980s. Future planetary explorations will have the advantage of prelaunch servicing at the Space Station.

The Space Station is the natural follow-on project in the methodical and orderly progress of the United States space program. By pursuing the development of the Space Station now our nation can help assure for itself a position of strength in the international competition for the commercial, technological and scientific gains that space brings.

# An International Magnet

## Nations Working Together

**"The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind . . .**

**"The aeronautical and space activities of the United States shall be conducted so as to contribute materially to . . . cooperation by the United States with other nations and groups of nations . . ."**

***From the U.S. National Aeronautics and Space Act which created NASA in 1958 and continues to guide its policies***

The adage that many heads are better than one applies well to international cooperation in space. Drawing on the expertise and talents of many nations has often yielded bigger and better dividends for each participant—greater rewards than if each nation had undertaken the same project individually.

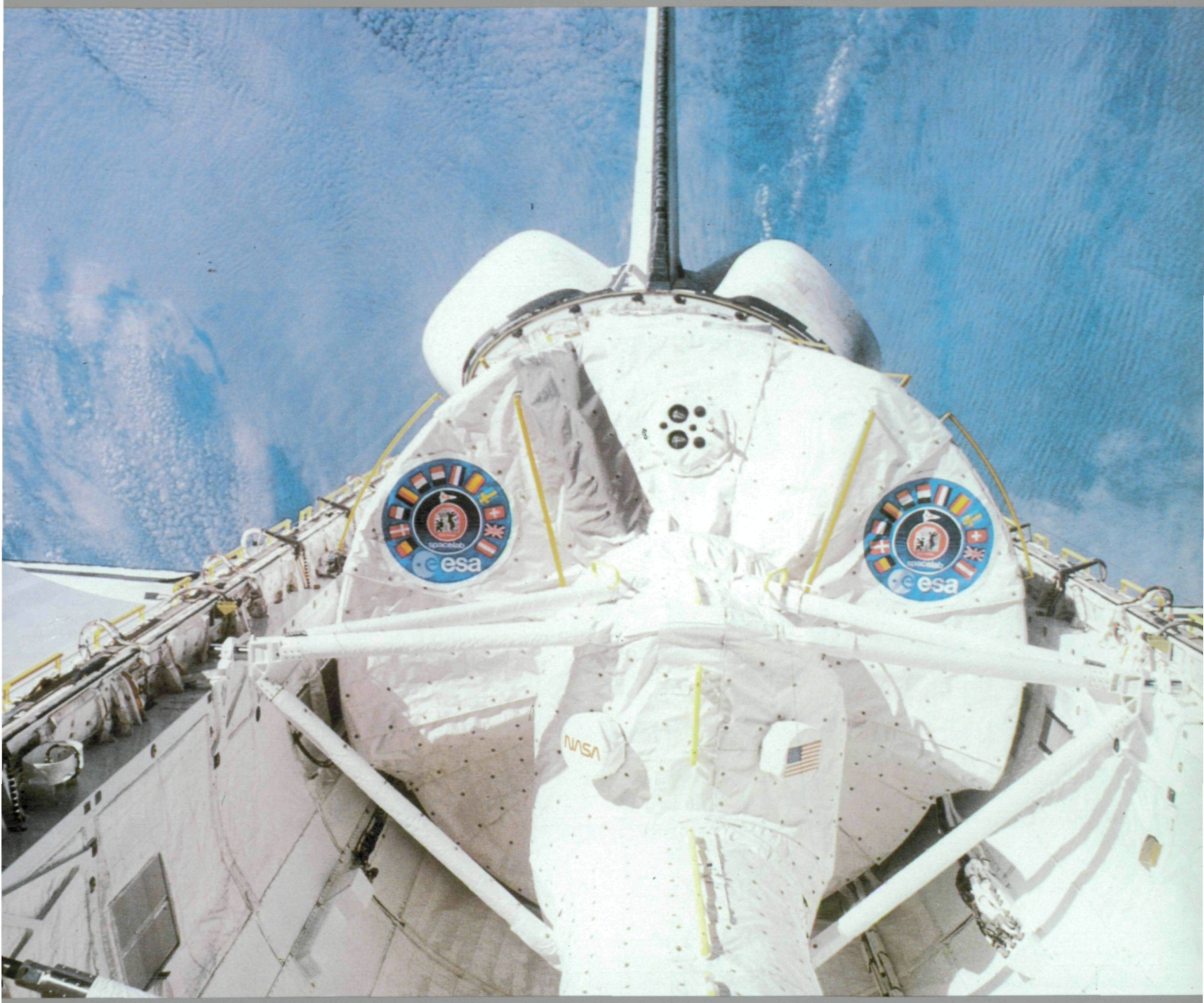
There are also more subtle advantages. Cooperation and coordination prevents diversion of valuable resources in needless duplication of efforts. Nations who might otherwise have found themselves fierce competitors have worked together instead, toward common objectives. Individual nations have even been able to retain possession of jealously guarded inventions and technological know-how while cooperating with each other.

Sharing work, facilities, costs and research results with other nations has been a guiding principle of NASA's space program from its beginning. When the Congress established NASA in 1958 by enacting the National Aeronautics and Space Act, it provided that space activities shall be conducted so as to contribute to cooperation by the United States with other nations.

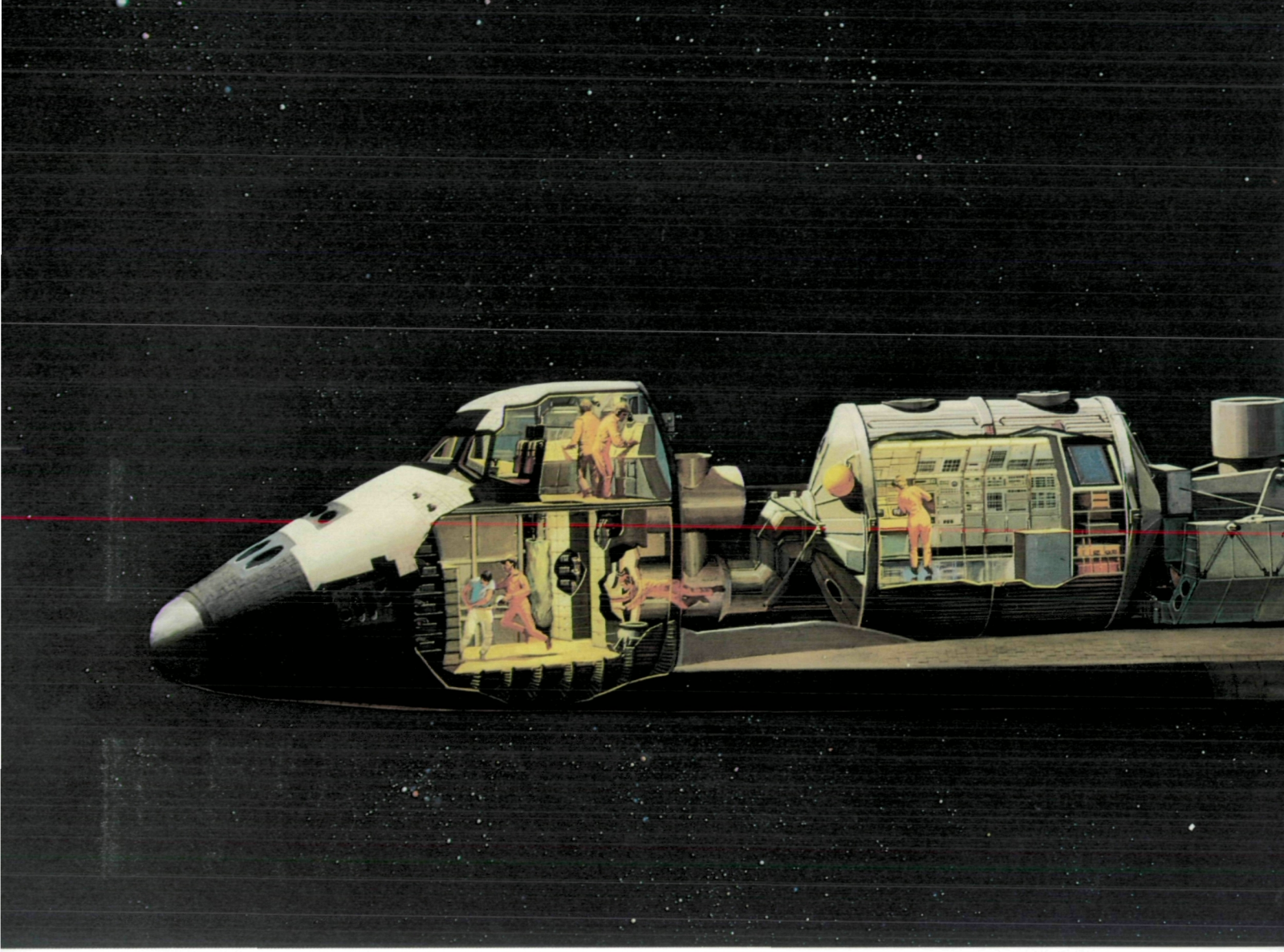
Since then the United States has signed more than 1,000 agreements with more than 100 nations for cooperative space activities. NASA launch vehicles have carried satellites owned by other nations into orbit. Several nations have provided sites for NASA stations in the global network for satellite tracking and communications. Experiments built and owned by other nations or jointly owned with the United States have been flown on NASA spacecraft. There have been extensive exchanges of space research information. And U.S. scientists have flown experiments on foreign spacecraft.

### International Cooperation In Space to Continue

This tradition of U.S. cooperation with other nations will continue with the Space Station. When President Reagan directed NASA to build the Space Station in January 1984 he emphasized foreign contributions. *We want our friends to help us meet these challenges and share in their benefits,* said




*Above the U.S. flag and NASA insignia are the emblems of the European Space Agency (ESA) in this photograph of the Space Shuttle Columbia's cargo bay during the ninth Shuttle flight in November 1983. The emblems, which include the flags of ESA member nations, are attached to Spacelab, the European-built science and technology space laboratory.*



*This cutaway illustration pictures Spacelab, a multipurpose science and technology laboratory. Developed by the European Space Agency, Spacelab sits in the cargo bay of the Space Shuttle and includes the manned cylindrical module (center) as well as instrument-laden, unmanned pallets shown here in the rear of the bay. Spacelab will fly throughout the 1980's and provide significant experience for Space Station operations.*

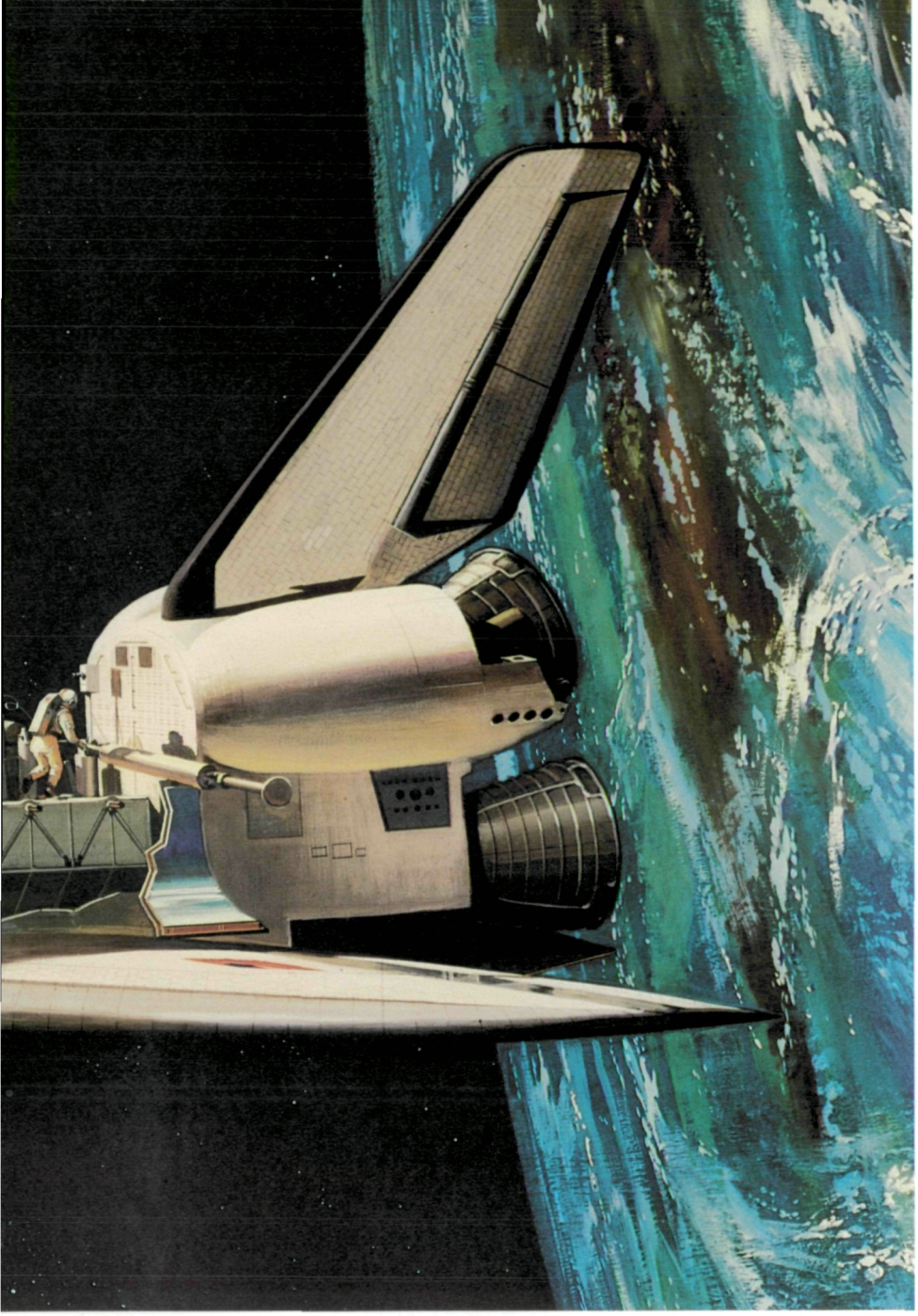


the President. *NASA will invite other countries to participate so we can strengthen peace, build prosperity and expand freedom for all who share our goals.*

In anticipation of the Station, several nations have already conducted extensive studies of their own on whether they want to participate and how they may want to become involved. Canada, France, Italy, Japan and West Germany—and separately the European Space Agency—have each focused studies on what components they might want to develop for the U.S. Space Station and in what ways they may want to use the Station's facilities once these become available.

### Cooperation In Space

In history's largest international space project, 10 European nations* working through the European Space Agency (ESA)



### *Message to NASA From the European Space Agency*

**"Your nation's historic decision to build a permanent Space Station has created great interest on all sides. It is another manifestation of your nation's capacity to create, to adapt and renew, which has shown itself in many ways throughout your history. It will favour the development of new space techniques.**

**"Following President Reagan's invitation to the friends and allies of the United States to participate in the Space Station program, and based on our own scientific and technological capabilities, we are considering ways to join forces with you for the advancement of this project and at the same time challenge our own imaginations and skills. We hope that the Space Station will enhance the extensive transatlantic cooperation which has served our peoples on both continents so well in the past."**

*E. Quistgaard*
*Director General*
*European Space Agency*

designed, built and paid for Spacelab, the billion-dollar science and technology laboratory which fits into the Shuttle's cargo bay.

For the United States Spacelab became a valuable addition for extending the Shuttle's research capabilities. For the Europeans Spacelab provided an entry into manned space flight without having to start a manned space program of their own.

A West German physicist, Dr. Ulf Merbold, was a member of the six-man crew during Spacelab's first flight aboard the Shuttle in November 1983, and he became the first non-American to be launched into space aboard a U.S. spacecraft.

Also extending the Space Shuttle's capabilities was Canada which built the Remote Manipulator System. It has

*Austria, Belgium, Denmark, France, West Germany, Italy, the Netherlands, Spain, Switzerland and the United Kingdom.

performed well in space, deploying payloads and capturing an orbiting satellite.

The same pattern of international cooperation is inherent in Italy's project to develop a satellite that is to be suspended on a long tether from the Shuttle. The satellite and Space Shuttle will be tied to each other by a tether extending over distances up to 60 miles—for research in the upper atmosphere and the near-space environment.

In another international project, a satellite named IRAS (Infrared Astronomy Satellite) made a breakthrough discovery. In August 1983, IRAS found the first evidence that there may by another solar system in the universe. The satellite's electronic eyes found that the star Vega, the fifth brightest in the sky, is surrounded by solid objects of substantial size, perhaps planets. Until that discovery there was no clear evidence that any star except the Sun had solid satellites. If the finding is confirmed by additional studies, it would strengthen speculation that life may have evolved elsewhere in the universe.

Even amid substantial cooperation between nations, vigorous, competition also exists in space. The European Space Agency in addition to Spacelab also built Ariane, an unmanned launch vehicle. Ariane is now competing with the Space Shuttle for the lucrative business of providing launch services for communications satellites owned by other countries or by private firms. As modern space technology turns the once hostile space environment into friendlier, more hospitable surroundings, both international cooperation and international competition in space appear to grow more intense.

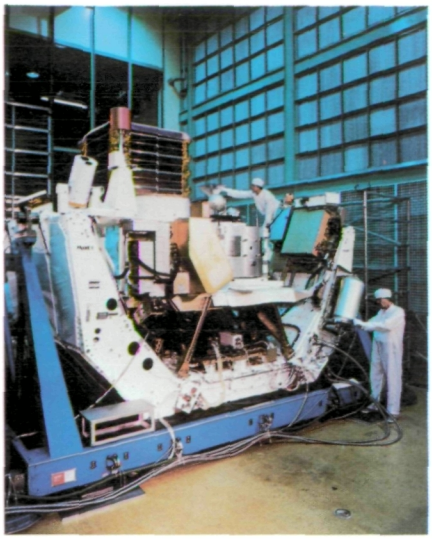
NASA Administrator James M. Beggs traveled to Europe and Japan in March 1984 to assess international interest in the U.S. Space Station program. Early responses indicate the Space Station will attract substantial international participation. Nations are likely to be drawn into the project because of the new possibilities for research, exploration and commercial applications.

*At the London Economic Summit in June 1984 the President explained the Space Station initiative to leaders of other nations. Mr. Reagan is shown here discussing the initiative with Prime Minister Thatcher of the United Kingdom and Prime Minister Nakasone of Japan.*



*Engineers prepare the Infrared Astronomy Satellite (IRAS) for flight. IRAS, a cooperative endeavor of the Netherlands, the United Kingdom and the U.S., was launched on January 25, 1983. It mapped 98 percent of the sky during its planned ten-month mission, measuring the infrared emission and location of more than 250,000 stars, galaxies and other celestial objects.*

*A widely-used, foreign-built piece of equipment used on the Space Shuttle is a U-shaped pallet like the one shown here being loaded with scientific instruments. Such pallets, which fit into the Shuttle's cargo bay, were designed and manufactured in Europe. As shown in the picture on the inside front cover, they could also be utilized on the Space Station.*





*An unmanned, free-flying satellite manufactured in West Germany is pictured here being unpacked in Florida for launch and retrieval by the Space Shuttle. The mission was successful and reflective of the international cooperation in space now occurring between the United States and other nations. Such cooperation is likely to continue in the Space Station era.*

# Gateway to the Future

## What the Space Station Means to All of Us

**"A bird is an instrument working according to mathematical law, which . . . it is within the capacity of man to reproduce."**

***Leonardo da Vinci (1452-1519), Italian artist, engineer, mathematician, and scientist and one of the first known theoreticians on aeronautics.***

The 20th century, which began with history's first flight of a power-driven aircraft at Kitty Hawk, North Carolina, will very likely end with the first truly permanent orbital human habitat firmly established in space.

The U.S. Space Station scheduled to begin operations in the early 1990s can be expected to have profound economic, social and psychological ramifications. In the long run these may become as pervasive in our lives as the explosive growth of aeronautics which began with that first flight more than 80 years ago.

The Space Station project may appear less spectacular than the flight at Kitty Hawk, Lindbergh's flight to Paris or the landings on the Moon. But it represents an equally great surge forward in the continuing quest to understand the laws and phenomena of nature and to put that knowledge to use for common benefit.

For early crews their stay in the Space Station may resemble life on an offshore oil drilling platform or at an Antarctic research station. In their remote outpost in the sky, they will experience isolation and distance from conventional communities. In time, as Space Station activities continue year after year, work in space will become as familiar as work in our factories, shops, offices and homes on Earth.

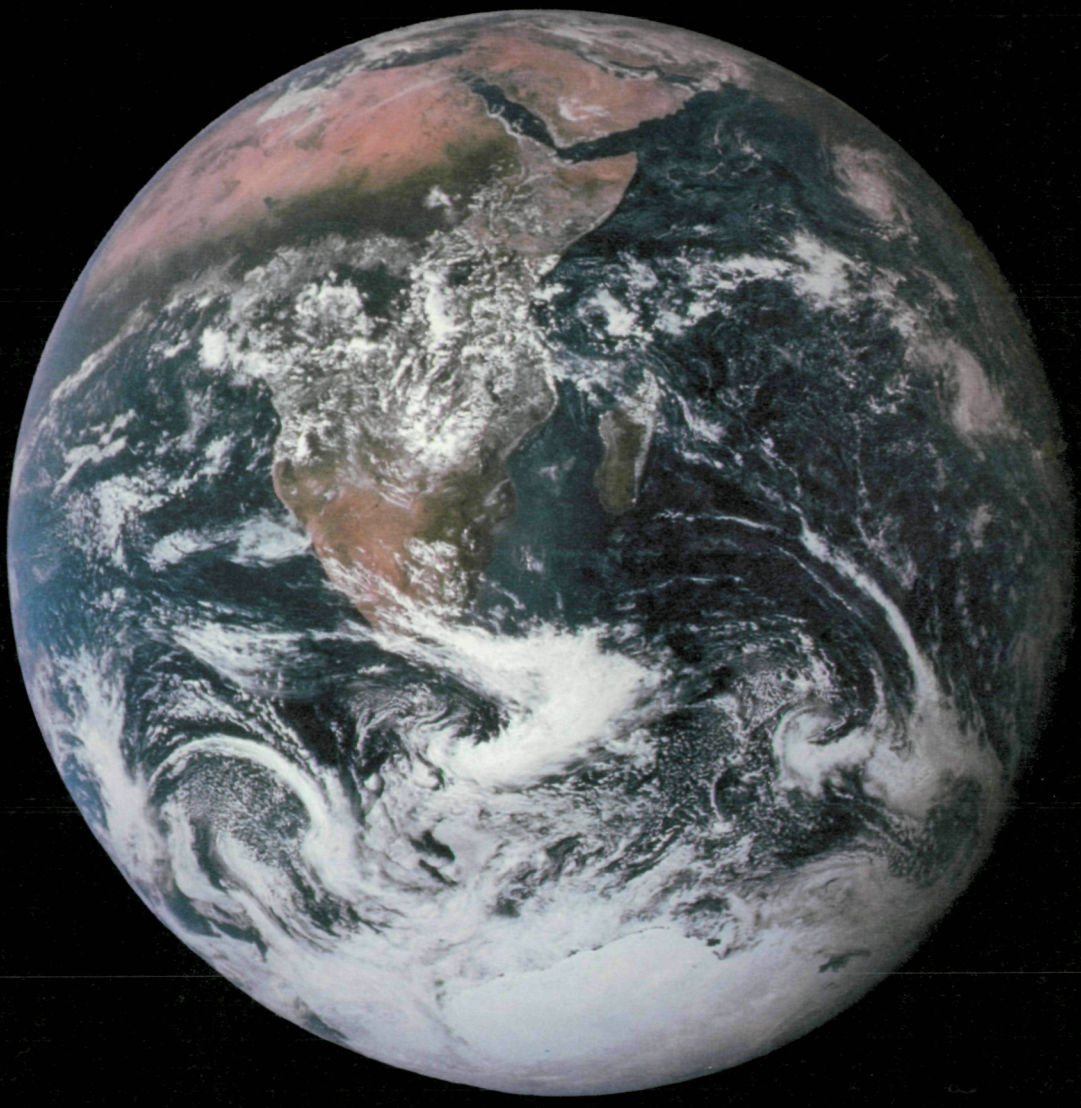
With its unlimited life span and its continuous occupancy by successive crews, the Space Station will turn humankind from transients to residents of space.

### Space Station: Living and Working in Space

In all U.S. manned space flights until now every moment of onboard activity from launch through landing was preprogrammed in a minute-by-minute timeline for each crew member. No such precise preplanning of work and living activities will be necessary for a small permanent space community. Crews will have to use their own judgment in setting priorities and arranging time schedules. Unexpected research results or repairs to a malfunctioning satellite and other unpredictable events will require crews to rely on their own initiatives and decision making.

Most previous space flights have been dominated by only one or a few major objectives—landing on the Moon, testing a new system, launching one or more satellites or carrying out certain experiments. No single goal is likely to dominate the Space Station for long. Its crew members will be specialists with widely different backgrounds, interests and assignments. The Station's versatility will make it available for multiple functions.

Like fishing trawlers and ocean oil rigs which gather food and fuel from far-away places, the Space Station will



*As the Space Shuttle Columbia returns on its fourth flight—on July 4, 1982—President and Mrs. Reagan prepare to watch it land. With them are NASA Administrator James M. Beggs (far left), astronauts Bob Crippen (second from left), and Joe Engle (right of the President).*

draw on the resources of space to satisfy needs here on Earth. Research, products and services flowing from the Space Station may in time make many Earth residents as dependent on the resources of space as large populations are today dependent on harvests from the seas. Users of life-sustaining medicines producible only in space could be among the first Earth residents relying on space resources for their well-being. This would be true also for future industries whose products will depend upon alloys or electronic components obtainable only in prolonged minimal gravity.

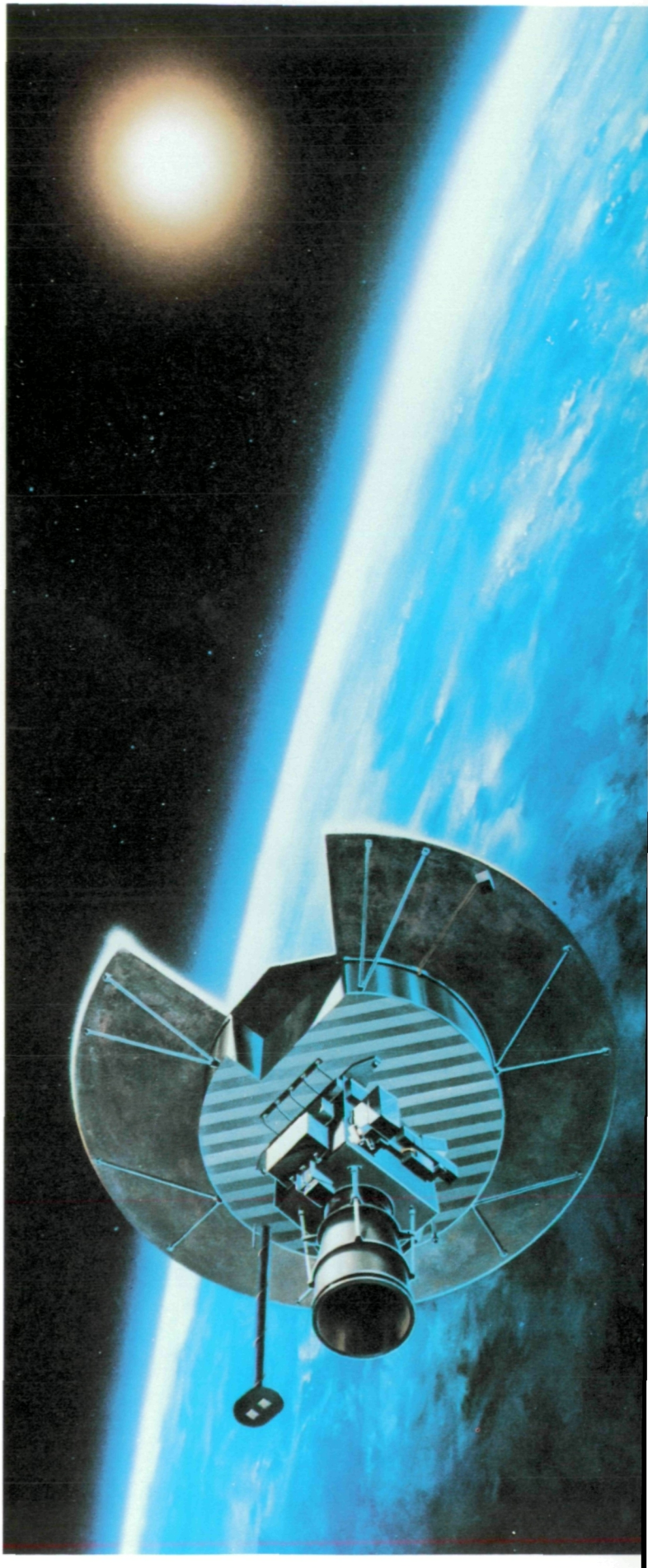
**Space Station: Looking to the Future**

In time, the Space Station may cause us to adjust our point of view so that we will look on these Earth-orbiting regions as integral parts of the Earth, like newly-found continents or oceans.

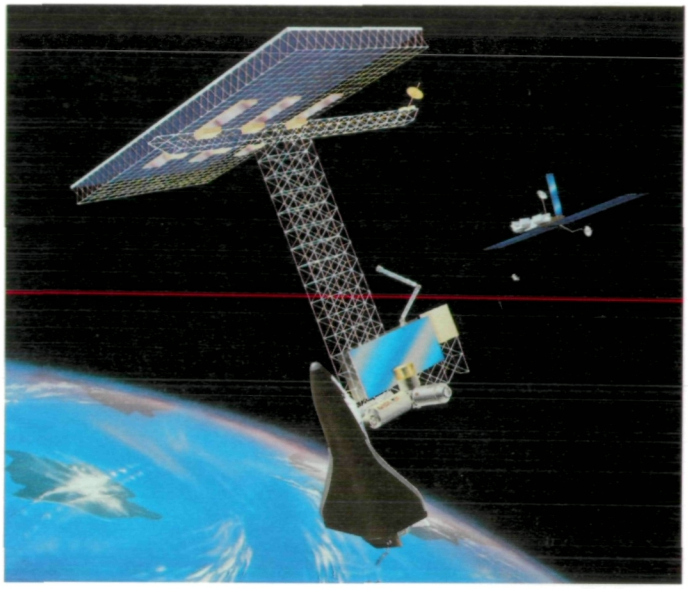
By then—perhaps in the late 1990s—commercial manufacturing activities in orbit may have outgrown the original Space Station. Modules especially designed to meet the precise needs of these commercial enterprises will have been added. Similarly, scientific research and applications needs will have expanded so that dedicated modules will have been added to satisfy these requirements.

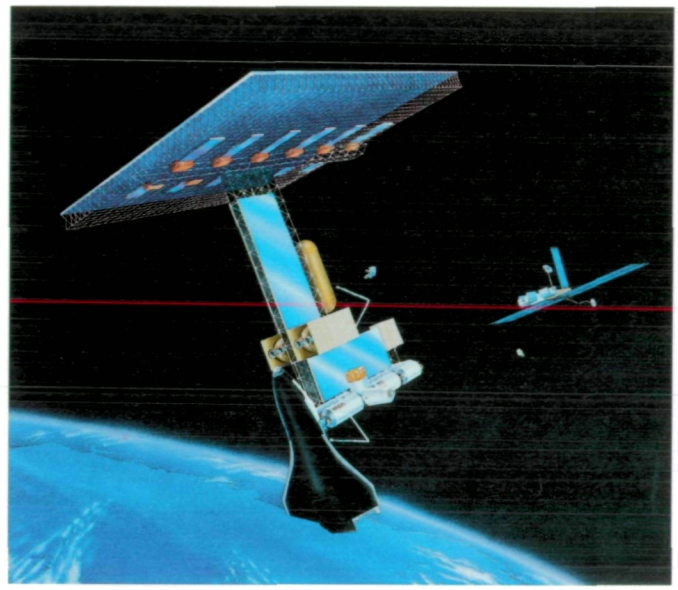
By that time the Space Station could be in the process of becoming a staging and launch base for manned voyages to the Moon, Mars and asteroids. Expeditions to these remote destinations can best be started from the Space Station rather than from Earth. By assembling the spacecraft in orbit and launching it there, it will not need to be equipped for a strenuous passage through the Earth's atmosphere. Instead, it can be constructed entirely for use in the vacuum of space with resulting economies and design advantages.

The Space Station with its added specialized modules for new functions and activities can become an important legacy of this generation to the 21st century.



*These two sets of illustrations highlight a principal feature of the Space Station: that it can evolve in size and capability over time. The Space Station to be operational in the early 1990's will be limited in scope but, regardless of the configuration finally selected, will be able to be increased in size and capability. "Scaling-Up" the initial Station, that is building in the ability to grow, is a difficult but essential engineering task.*





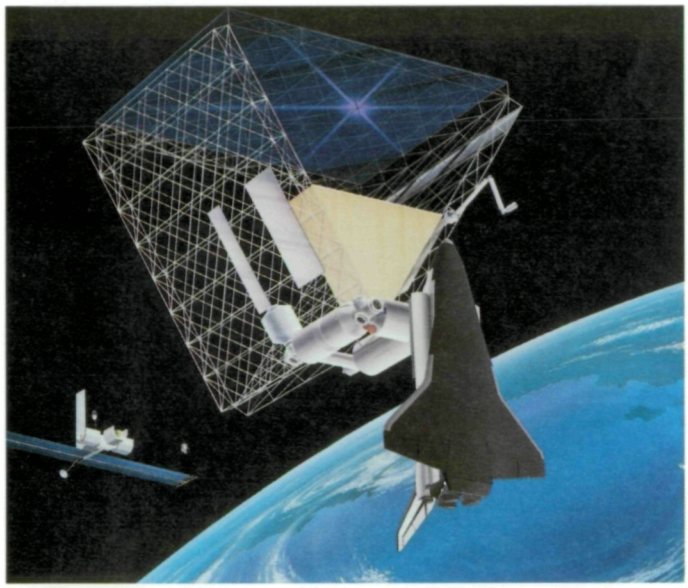


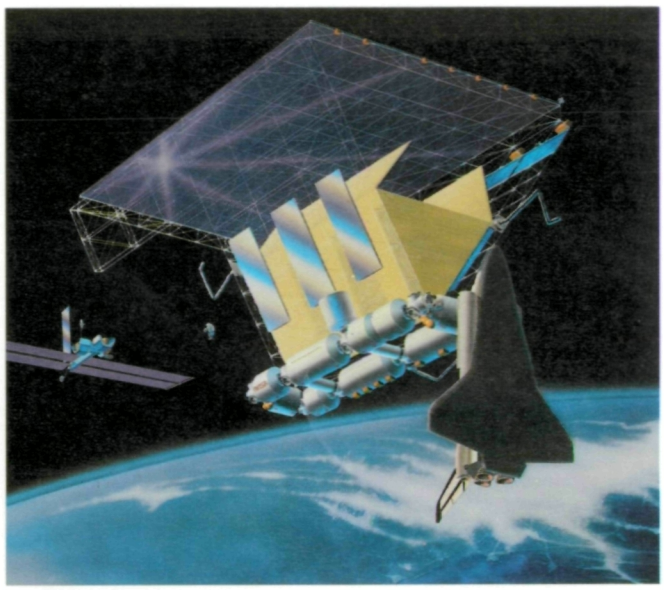
**Space Station: A Symbol For America**

Like earlier NASA space projects, the permanent Space Station will be a source of national pride. It will be a peaceful symbol of America's strength and resolve. It will kindle technological innovation, imagination and creativity. It will inspire our young men and women toward greater achievements, encouraging many of them to seek careers in science and technology.

If the U.S. Space Station is ready to begin work in the early 1990s as is now expected, the beginning of a permanent human presence in space would come about 30 years after Alan B. Shepard, Jr., became the first American in space with a 15-minute suborbital flight (on May 5, 1961); some 65 years after propulsion pioneer Dr. Robert H. Goddard launched the world's first liquid-fuel rocket (on March 16, 1926); and about 90 years after Orville and Wilbur Wright achieved sustained flight with a power-driven aircraft (December 17, 1903).

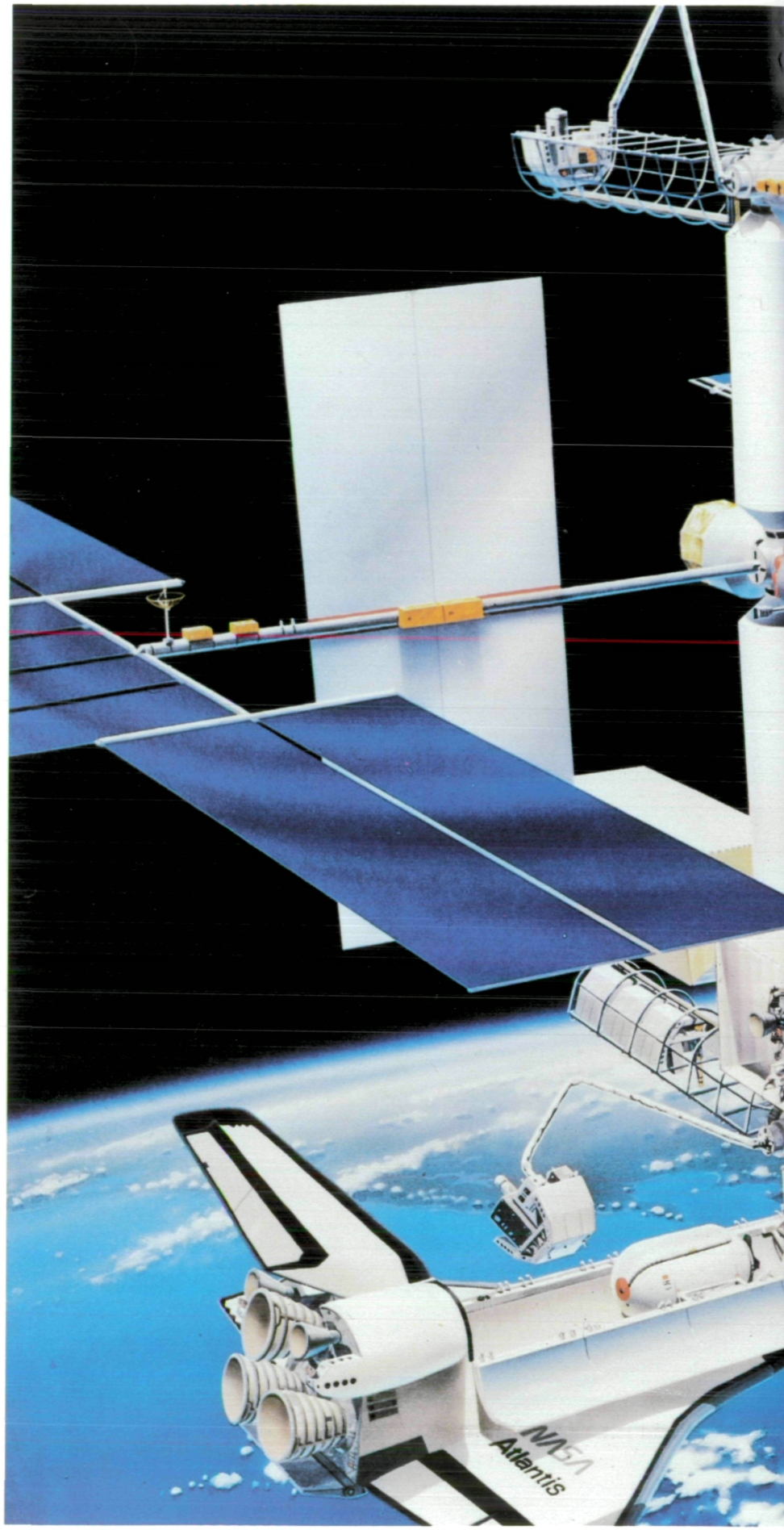
America's permanently manned Space Station will become operational at about the time of the 500th anniversary of the discovery of the New World. That discovery by Christopher Columbus and his crew in 1492 led to colossal changes for humankind. In the long sweep of history, the Space Station may do as much.





**"The success of the Space Shuttle and the advent of the Space Station focus our attention upon a basic question: Why do we have a civil space program? Why do we concern ourselves with rockets and satellites? My own view is that we have a space program not because of the excitement the program engenders and certainly not because the Russians have one. You have a space program because there are things you can do in space that you can't do on the ground. What things? Astronomy, materials research, navigation and communications, Earth observations, are all activities that lend themselves to space and there are others. Space has become simply a place where we do useful things."**

***Representative Bob Traxler, U.S. House of Representatives 8th District-Michigan***

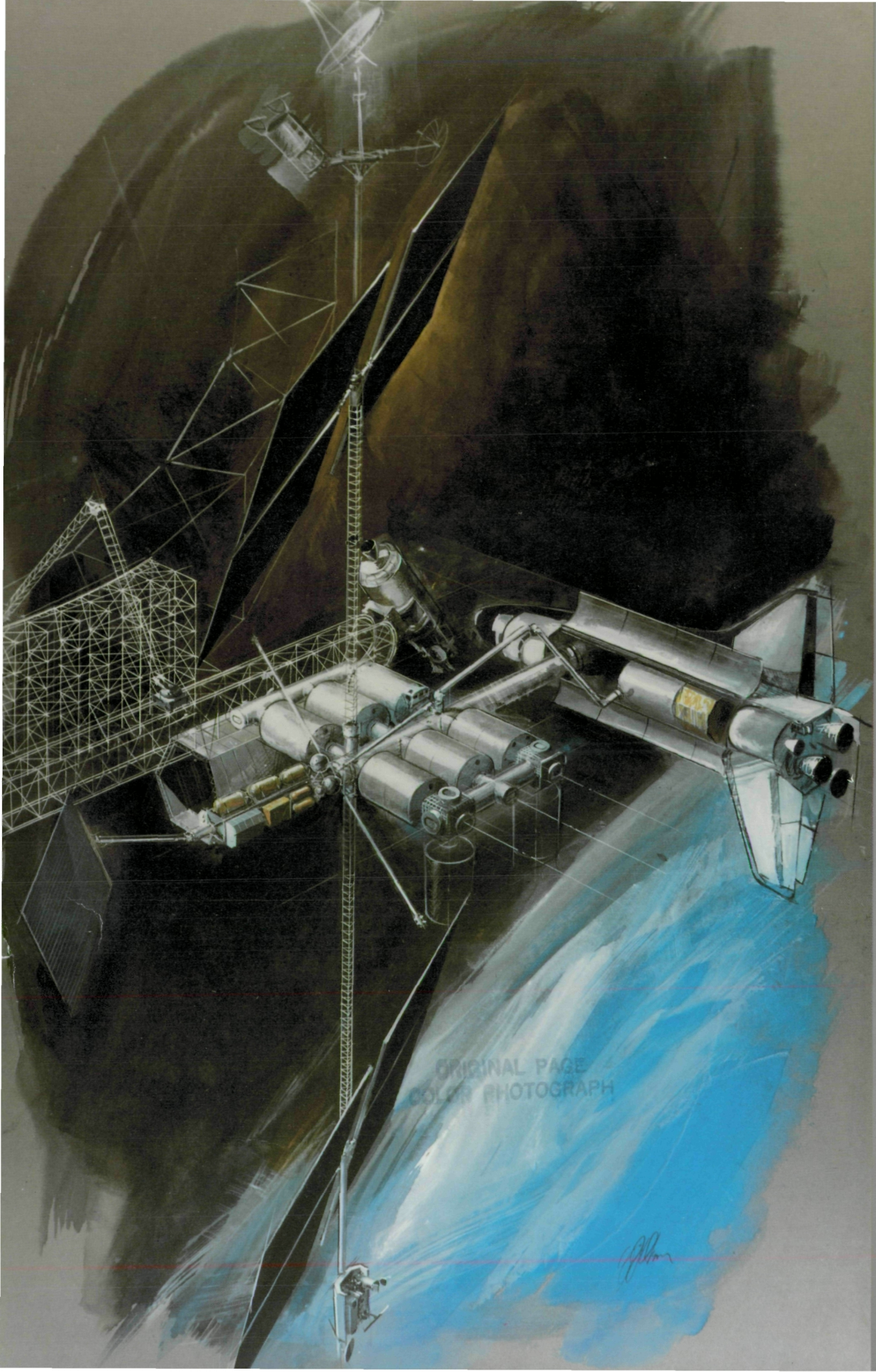



*NASA and its industry and international partners will design the Space Station in such a way as to enable the Station to grow in size and capability over time, as needs arise. This evolutionary character of the Space Station is central to the design effort. Shown here is a fully developed configuration. Compare this with the more modest initial capability of the same configuration pictured on the inside front cover.*

"We can follow our dreams to distant stars, living and working in space for peaceful economic and scientific gain. Tonight, I am directing NASA to develop a permanently manned Space Station and to do it within a decade.

A Space Station will permit quantum leaps in our research in science, communications and in metals and life-saving medicines which can be manufactured only in space."

*President Ronald Reagan*
*State of the Union Message*
*January 5, 1984*



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